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Draft Environmental Impact Statement

Renewal of the Federal Grant for the Trans-Alaska Pipeline System Right-of-Way

Volume 2: Sections 4.1 through 4.6

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Notation

The following is a list of acronyms and abbreviations (including units of measure) used in this document. Certain abbreviations used only in tables, equations, and as reference callouts are not included here but are defined in the respective tables, equations, and reference lists.

Acronyms and Abbreviations

AAAQS	Alaska Ambient Air Quality Standards
AAC	Alaska Administrative Code
AADT	annual average daily traffic
ACEC	areas of critical environmental concern
ACM	asbestos-containing materials
ACMA	Alaska Coastal Management Act
ACMP	Alaska Coastal Management Program
ACS	Alaska Clean Seas
ADEC	Alaska Department of Environmental Conservation
ADF&G	Alaska Department of Fish and Game
ADGC	Alaska Department of Government Coordination
ADNR	Alaska Department of Natural Resources
ADT	average daily traffic
AFB	Air Force Base
AFFF	aqueous film-forming foam
AFN	Alaska Federation of Natives
AK	Alaska
AKOSH	Alaska Occupational Safety and Health
ALOHA	Areal Locations of Hazardous Atmospheres
AMHS	Alaska Marine Highway System
AMM	asset maintenance management
ANCSA	Alaska Native Claims Settlement Act
ANILCA	Alaska National Interest Lands Conservation Act
ANSI	American National Standards Institute
ANUA	Alaska Native Utilization Agreement
ANWR	Arctic National Wildlife Refuge
AO	Authorized Officer (Joint Pipeline Office)
AOGCC	Alaska Oil and Gas Conservation Commission
APHIS	Animal and Plant Health Inspection Service
API	American Petroleum Institute
APSC	Alyeska Pipeline Service Company
AQCR	Air Quality Control Region
AQRV	air-quality-related value
ARCO	Atlantic Richfield Company
ARRC	Alaska Railroad Corporation
ARRT	Alaska Regional Response Team
AS	Alaska Statute
ASME	American Society of Mechanical Engineers
ATV	all-terrain vehicle
BE	biological evaluation
BLM	Bureau of Land Management (U.S. Department of the Interior)
BLS	Bureau of Labor Statistics
BMP	best management practice
BOD	biochemical oxygen demand

BOD_5	biochemical oxygen demand measured over a five-day period
BP	British Petroleum
BPXA	British Petroleum Exploration (Alaska), Inc.
BS&W	basic sediments and water
BTEX	benzene, toluene, ethylbenzene, xylene
BTT	biological treatment tank
BWT	ballast water treatment
BWTF	Ballast Water Treatment Facility
BWTS	ballast water treatment system
CBR	Constitutional Budget Reserve
CBRF	Constitutional Budget Reserve Fund
CCP	Central Processing Plant
CDMS	Corrosion Data Management System
CEO	chief executive officer
CEQ	Council on Environmental Quality
CFC	chlorofluorocarbon
CFR	Code of Federal Regulations
CMP	coastal management program
CNG	compressed natural gas
CO	carbon monoxide
CO_2	carbon dioxide
CP	Contingency Plan
CPF	Central Production Facility
CS	containment site
CSU	conservation system unit
CY	calendar year
CZ	coastal zone
CZM	coastal zone management
CZMA	Coastal Zone Management Act
DAF	dissolved air flotation
DBGC	designated big-game crossing
DCE	design contingency earthquake
DDT	dichloro-diphenyl-trichloro-ethane
DEIS	draft environmental impact statement
DHCMA	Dalton Highway Corridor Management Area
DOE	U.S. Department of Energy
DOI	U.S. Department of the Interior
DOT	Department of Transportation
DOT/OPS	Department of Transportation, Office of Pipeline Safety
DRA	drag reducing agent
DRO	diesel-range organics
DS	drill site
DSMA	digital strong-motion accelerograph
EIA	Energy Information Administration
EFH	essential fish habitat
e.g.	exempli gratia (for example)
EGHP	exhaust-gas horsepower
EIA	Energy Information Administration
EIS	environmental impact statement
EMS	environmental monitoring system
EPA	U.S. Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act
ER	environmental report
ERPG	emergency response planning guideline
ERV	Escort Response Vessel

ESA	Endangered Species Act
et al.	and others
FAA	Federal Aviation Administration
FACA	Federal Advisory Committee Act
FDA	U.S. Food and Drug Administration
FDS	Fire Dynamics Simulation (computer model)
Fe	iron
Fe_2O_3	ferric oxide
FEIS	final environmental impact statement
FR	Federal Register
FSIH	Fire Safety and Industrial Hygiene
FTE	full-time equivalent
GAO	General Accounting Office
GC	Gathering Center
GHG	greenhouse gas
GIS	geographic information system
GMU	Game Management Unit
GNOME	General NOAA Oil Modeling Environment
GRO	gasoline-range organics
GSP	gross state product
H_2O_2	hydrogen peroxide
H_2S	hydrogen sulfide
HAP	hazardous air pollutant
HAZCORE	Hazardous Materials Consolidation and Redistribution
HAZMAT	hazardous material
HC	hydrocarbon
HCFC	hydrochlorofluorocarbon
HCl	hydrogen chloride
Hg	mercury
HRR	heat release rate
HVAC	heating, ventilation, and air conditioning
i.e.	that is (id est)
IMPROVE	Interagency Monitoring of Protected Visual Environments
IRIS	Integrated Risk Information System
IRT	Initial Response Team
ISC3	Industrial Source Complex Model (Version 3)
ISCST	Industrial Source Complex Short Term
IWSS	industrial wastewater sewer system
JPO	Joint Pipeline Office
L_{dn}	day-night average sound level
L_{eq}	equivalent steady sound level
LEFM	leading-edge flow meter
LNG	liquefied natural gas
LVB	line volume balance
MAP	Man in the Arctic Program
MCCF	mobile contingency camp facility
MCL	maximum contaminant level
MEI	maximally exposed individual
MEK	methyl ethyl ketone
MGV	manual gate valve
MLA	Mineral Leasing Act

MLR	Mainline Refrigeration
MMC	Marine Mammal Commission
MMPA	Marine Mammal Protection Act
MMS	Minerals Management Service
MOA	memorandum of agreement
MP	milepost
MSDS	Material Safety Data Sheets
MSFCMA	Magnuson-Stevens Fisheries Conservation and Management Act
MSGP	Multi-Sector General (NPDES) Permit
MSWLF	municipal solid waste landfill
N	nitrogen
NAAQS	National Ambient Air Quality Standards
NADP	National Atmospheric Deposition Program
NAICS	North American Industry Classification System
NANA	Northwest Alaska Native Association
NEPA	National Environmental Policy Act
NF	National Forest
NFRAP	no further remedial action planned
NGL	natural gas liquid
NH_3	ammonia
NHPA	National Historic Preservation Act
NMDS	National Missile Defense System
NMFS	National Marine Fisheries Service
no.	number
NO_x	nitrogen oxides
NO_2	nitrogen dioxide
NO_3^-	nitrate
NOAA	National Oceanic and Atmospheric Administration
NOD	Notice of Disposal
NOI	Notice of Intent
NORM	naturally occurring radioactive material
NP	national park
NPDES	National Pollutant Discharge Elimination System
NPP	national park and preserve
NPR	National Petroleum Reserve
NPR-A	National Petroleum Reserve-Alaska
NPS	National Park Service
NRA	national recreation area
NRHP	National Register of Historic Places
NS	North Slope
NSB	North Slope Borough
NSC	National Safety Council
NSPTS	North Slope Production and Transportation System
NWR	national wildlife refuge
NWS	National Weather Service
O_3	ozone
O&M	operation and maintenance
OCC	Operations Control Center
OCS	Outer Continental Shelf
ODC	ozone-depleting chemical
ODP	ozone-depleting potential
ODS	ozone-depleting substance
OMB	Office of Management and Budget
OMS	operational material site
OPA	Oil Pollution Act
OPS	Office of Pipeline Safety (U.S. Department of Transportation)

ORC	oxygen-releasing compound
ORV	off-road vehicle
OSHA	Occupational Safety and Health Administration
OSHTF	(Alaska) Oil Spill Health Task Force
OSPPR	Oil Spill Prevention, Preparedness, and Response
OSV	oil spill volume
P	phosphorus
PA	Programmatic Agreement
PAH	polycyclic aromatic hydrocarbon
PAI	Phillips Alaska, Inc.
Pb	lead
PBT	persistent, bioaccumulative, and toxic
PCB	polychlorinated biphenyl
PDF	pipeline design flood
PELs	permissible exposure limits
PF	Permanent Fund
PG	Pasquill-Gifford
pH	hydrogen ion concentration
P.L.	Public Law
PM	particulate matter
$PM_{2.5}$	particulate matter with a diameter less than or equal to 2.5 micrometers
PM_{10}	particulate matter with a diameter less than or equal to 10 micrometers
PMP	probable maximum precipitation
PO_4^{3-}	phosphate
POP	persistent organic pollutant
POTW	publicly owned treatment works
PPE	personal protective equipment
PPV	peak particle velocity
PRT	prevention and response tug
PS	pump station
PSD	Prevention of Significant Deterioration
PWS	Prince William Sound
QA	quality assurance
RCM	reliability-centered maintenance
RCRA	Resource Conservation and Recovery Act
REAA	Regional Educational Attendance Area
RGV	remote gate valve
RMP	Resource Management Plan
ROD	Record of Decision
ROS	recreation opportunity spectrum
ROW	right-of-way
RRO	residual-range organics
RSC	reduced sulfur compounds
SARA	Superfund Amendments and Reauthorization Act
SCADA	supervisory control and data acquisition
SD	standard deviation
SDWA	Safe Drinking Water Act
SERVS	Ship Escort/Response Vessel System
SHPO	State Historic Preservation Officer
Si	silicon
SIC	Standard Industrial Classification
SIP	state implementation plan
SO_2	sulfur dioxide
SO_x	sulfur oxides

SPC	State Pipeline Coordinator
spp.	species
SRS	state recreation site
Stat.	statute
SWDS	solid waste disposal site
SWPPP	Storm Water Pollution Prevention Plan
SWTP	sanitary waste treatment plant
TAPAA	Trans-Alaska Pipeline Authorization Act
TAPS	Trans-Alaska Pipeline System
TAGS	Trans-Alaska Gas System
TCA	1,1,1-trichloroethane
TCP	traditional cultural property
TEEL	temporary emergency exposure limit
TEF	toxic equivalency factor
TLV	threshold limit value
TPQs	Threshold Planning Quantities
TRI	Toxics Release Inventory
TSDF	treatment storage and disposal facility
TSP	total suspended particulates
TSS	total suspended solids
TVB	transient volume balance
TVR	tanker vapor recovery
UAA	University of Alaska-Anchorage
UIC	underground injection control
USACE	U.S. Army Corps of Engineers
USC	United States Code
USCG	United States Coast Guard
USDA	U.S. Department of Agriculture
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
UV	ultra-violet
VAHS	Valdez Air Health Study
VHF	very high frequency
VHS	viral hemorrhagic septicemia
VMT	Valdez Marine Terminal
VOC	volatile organic compound
VRM	visual resource management
VSM	vertical support member
VTS	Vessel Traffic Service
WSR	Wild and Scenic River
ZRAs	Zone of Restricted Activities

Units of Measure

acre-ft	acre-foot (feet)
bbl	barrel(s)
Btu	British thermal unit(s)
°C	degrees centigrade
cm	centimeter(s)
cm^3	cubic centimeters
cSt	centistoke(s)
d	day
dB	decibel(s)
dBA	A-weighted decibel(s)
°F	degrees Fahrenheit
ft	foot (feet)
ft^2	square foot (feet)
ft^3	cubic foot (feet)
g	gravitational acceleration
gal	gallon(s)
GW	gigawatt(s)
h	hour(s)
ha	hectare(s)
hp	horsepower
in.	inch(es)
$in.^2$	square inch(es)
j	joule(s)
K	kelvin degree(s)
kg	kilogram(s)
km	kilometer(s)
km^2	square kilometer(s)
knot	nautical mile(s) per hour
kW	kilowatt(s)
L	liter(s)
lb	pound(s)
m	meter(s)
m^2	square meter(s)
m^3	cubic meter(s)
mg	milligram(s)
mi	mile(s)
mi^2	square mile(s)
min	minute(s)
mL	milliliter(s)
mm	millimeter(s)
mmole	millimole(s)
mph	mile(s) per hour
MW	megawatt(s)
MYA	million years ago
ng	nanogram(s)
pCi	picocurie(s)
ppb	part(s) per billion
ppm	part(s) per million
psi	pound(s) per square inch
psig	pound(s) per square inch gauge
rpm	revolution(s) per minute
s	second(s)
scf	standard cubic foot (feet)
scfm	standard cubic foot (feet) per minute
wk	week(s)
YA	years ago
yd	yard(s)
yd^3	cubic yards
yr	year(s)
µg	microgram(s)
µg-atoms	microgram-atoms
µm	micrometer(s)
µmole	micromole(s)
µR	microroentgen(s)
$/bbl	dollar per barrel

4. Environmental Consequences

4.1 Existing Mitigation Measures

4.1.1 JPO Oversight

The member agencies that make up the JPO cooperatively monitor TAPS and TAPS activities. Table 4.1-1 lists the federal and state agencies that compose the JPO and their primary areas of responsibility. The JPO now exercises comprehensive oversight of all aspects of TAPS operations covered by the Federal Grant and the State Lease. Aspects include those covered by technical, environmental, and general stipulations as well as by the requirements of the 41 sections of the Federal Grant and the 42 sections of the State Lease.

The fundamental objective of all JPO oversight is to ensure that APSC, as the Permittees' common agent, complies with all expectations delineated in the Federal Grant and State Lease and their stipulations. Specifically, APSC must:

- Know all of the applicable requirements that derive from the Federal Grant and State Lease stipulations, state and federal regulations, permit conditions, and other government directives;
- Obtain all the necessary permits and authorizations to operate the TAPS;
- Take reasonable and prudent actions to detect operational or design deficiencies (the expected result of stipulations related to surveillance programs, safety programs, quality programs, and abatement requirements); and
- Correct observed deficiencies in a timely manner according to risk-based priorities.

JPO member agencies have clear and direct regulatory authority over various TAPS activities. Essentially, JPO member agencies perform five compliance activities:

1. Issue necessary permits and authorizations to operate the TAPS;
2. Monitor the TAPS and TAPS activities to identify situations requiring corrective action;
3. Approve construction or other actions;
4. Perform direct compliance or remediation actions, as necessary, to protect public safety and health, the environment, and pipeline integrity; and
5. Respond to oil spills and other abnormal conditions.

Once the JPO, through the appropriate governmental process, directs APSC to conduct a corrective action (including compliance or remediation activities), APSC must comply. APSC's failure to comply in a sufficient and timely manner may result in civil or criminal penalties levied by regulatory agencies or in termination or civil penalties under the Federal Grant, using the process described in Federal Grant Section 31.

Before construction or certain other actions can occur, APSC must conduct reviews mandated in the Alaska Coastal Management Program, when appropriate, and it must obtain permits and other authorizations from JPO agencies. These include Notice to Proceed decisions from the BLM and ADNR that are based on the requirements of the Federal Grant and State Lease, as well as regulatory required authorizations, such as wetlands permits from the USACE and fish passage permits from the ADF&G. Through these permitting processes, federal and state agencies can require coordinated measures designed to avoid or mitigate harmful impacts that might result from TAPS actions.

TABLE 4.1-1 Federal and State Agencies within the Joint Pipeline Office

Federal Agency	State Agency
U.S. Department of the Interior/Bureau of Land Management Issues and administers ROWs and permits for land use and issues and administers material sales related to pipeline use on federal land.	*Alaska Department of Natural Resources* Administers state-owned land and administers rights granted in land-use leases, permits, material sales, water rights, and water use.
U.S. Department of Transportation/Office of Pipeline Safety Regulates the transportation of hazardous liquids and gases by pipeline, regulates drug testing related to pipeline safety, and conducts inspections of the TAPS.	*Alaska Department of Environmental Conservation* Issues permits to operate facilities that could affect air quality, generate waste, and treat, store, and dispose of hazardous material; regulates these facilities; and approves oil spill contingency plans.
U.S. Environmental Protection Agency Works in partnership with the ADEC to administer regulatory programs such as the Clean Air Act, Clean Water Act, and Oil Pollution Act.	*Alaska Department of Fish and Game* Regulates activities affecting fish passage, anadromous fish streams, and hazing of wildlife in connection with oil spills.
U.S. Coast Guard Issues permits for structures over navigable waters and oversees vessels and terminal safety.	*Alaska Department of Labor* Reviews practices and procedures pertaining to occupational safety and health; mechanical, electrical, and pressure systems; and wage and hour codes to protect employees of the pipeline company.
U.S. Army Corps of Engineers Issues approvals of structures or activities in navigable waters and approvals of placement of dredged or fill material in U.S. waters, including wetlands.	*Alaska Division of Governmental Coordination* Coordinates the review of projects under the Alaska Coastal Management Program and consolidates state comments on NEPA issues.
U.S. Department of the Interior/Minerals Management Service Manages the nation's natural gas, oil, and other mineral resources on the Outer Continental Shelf.	*State Fire Marshal's Office* Conducts fire and safety inspections, reviews plans, investigates fires, and provides safety education to the public.
	Alaska Department of Transportation/Public Facilities Designs, constructs, and maintains primary and secondary land and marine highways and airports.

Source: JPO (2002a).

4.1.1.1 Compliance Requirements and the Role of the Government and the JPO

Compliance requirements derive from many sources. TAPS-specific requirements are found in the following:

- The Federal Grant contains sections and stipulations under the authority of the MLA, the TAPAA, and the contractual terms of the Agreement between the Permittees (TAPS Owners) and the DOI.
- The State Lease contains sections and stipulations under the authority of Alaska Statute 38.35. These sections and stipulations often mirror those of the Federal Grant.
- The Federal Grant and State Lease also require the Permittees to comply with regulations based on numerous laws, each with its own enforcement protocol.
- In addition, certain permits and authorizations are required for specific activities (e.g., ADF&G Title 16 permits are required for activities that could affect fish habitats), for specific programs (e.g., Oil Spill Contingency Plans approved by the BLM and by the ADEC, among other agencies, are required), and for specific land uses (e.g., federal temporary use permits, mineral material site permits, or state land use permits may be required).

4.1.1.2 Adaptive Nature of the Grant in Compliance Monitoring

The two “landlord” agencies, the BLM and ADNR, have additional broad management authority stemming from the basic landlord-tenant relationship. The TAPAA gives the DOI broad powers to add requirements related to the construction, operation, maintenance, and termination of the TAPS in order to protect the public interest. The Federal Grant and State Lease stipulations — specifically Stipulations 1.3.2, 1.8, and 3.2.1.2 — reflect the scope of that broad authority.

Since the beginning of TAPS operations, the BLM has exercised its authority under Stipulations 1.3.2 and/or 3.2.1.2 on 11 separate occasions by issuing interpretive letters that either clarify existing technical requirements contained in the Federal Grant or introduce new technical requirements deemed appropriate as a result of the JPO’s review of operating and empirical data. The topics addressed in these interpretive letters include earthquake monitoring, fault monitoring, glacier surge monitoring, vegetation clearing and management, depth of cover at buried main-line pipe, zones of restricted activities for peregrine falcons and other raptors, performance standards for aboveground (structural) systems for seismic and hydraulic events, performance standards for restoration, pipe curvature standards, and zones of restricted activities for key fish areas (JPO 2002b).

4.1.1.3 Risk-Based Compliance Monitoring

All aspects of TAPS operations are subject to JPO monitoring. However, activities having the greatest potential impacts on public safety and health, the environment, or pipeline integrity are examined more often and more closely. Similarly, prior problem areas usually warrant periodic reviews with regard to their recurrence. The JPO’s compliance oversight is not an event but rather an ongoing process within which the JPO continually monitors TAPS operations and engages TAPS representatives in developing and implementing solutions to observed “deficiencies” and “noncompliance conditions.” These deficiencies and noncompliance conditions are tracked in JPO databases as “findings.” Maintaining these databases provides the impetus for tracking and follow-up on any open or unresolved findings. The databases can also highlight recurring problems that might be indicative of systemic design or programmatic weaknesses.

4.1.1.4 JPO Comprehensive Monitoring Program

The comprehensive monitoring program was established in 1994 to provide structured monitoring and reporting mechanisms to support enforcement of the Federal Grant and State Lease requirements. Prior to 1994, monitoring focused on protection of surface resources, oil spill contingency capabilities, corrosion abatement, and land use permitting issues. The ROW was the primary area of the JPO's attention. However, audits conducted in 1993 and thereafter found many problems within the pump stations and the Valdez Marine Terminal (see JPO Annual Reports for 1994–1996 [JPO 1995, 1996, 1997]). As a result, the JPO has recognized that risk can exist in all facets of TAPS operations and can originate anywhere within the TAPS infrastructure. Consequently, the JPO's oversight has moved toward a broader, more comprehensive oversight and audit program that evaluates not only APSC's performance with regard to promises it made to the U.S. Congress, but also the overall effectiveness of APSC's efforts to address employee concerns and maintain program quality. The Audit Action Item Closure procedures developed by the JPO provide a valuable tool for supporting this broader oversight objective and for keeping the efforts to resolve problems made by all parties in focus and on schedule.

As a result of the JPO's broadened monitoring scope, its technical staff has developed considerable expertise in pipeline operations in general and APSC processes in particular. The JPO monitors have the ability to evaluate not only the compliant status of the TAPS but also the effectiveness of the processes by which compliance is being pursued and maintained.

The comprehensive monitoring program is a three-tiered process for monitoring TAPS activities that involves surveillance, assessment, and reporting. Surveillance is the most frequent and routine monitoring function and normally involves physical inspections as well as reviews of critical operating and monitoring data. The JPO has access to all APSC monitoring data, and some data are formally reported to the JPO by APSC. In addition, JPO surveillance also verifies that APSC has adhered to its own internal procedures in its conduct of operations, especially with respect to the collection of monitoring data. (Additional discussions on APSC procedures are provided in Section 4.1.3.) Surveillance is the JPO's primary mechanism for verifying compliance with Federal Grant and State Lease requirements.

Surveillance actions take limited-scope "snapshots" of compliance issues. The subsequent surveillance reports separate observations into measurable parts called "attributes." Each attribute specifies the requirement; documents how it was measured or observed; and judges whether the observation was satisfactory, unsatisfactory, or corrected on the spot. If the unsatisfactory condition is individually significant or represents a serious compliance deficiency, then a finding is formally issued to APSC. Otherwise, information on the unsatisfactory conditions is entered into a database for analysis at the assessment or technical report level. To date, the JPO has accumulated a significant cache of information from more than 1,300 surveillances that can be used in a variety of ways to focus and direct TAPS oversight activities. Data from surveillance actions can be used for trend analyses or can directly result in a decision to conduct more in-depth technical studies that will contribute to the issuance of a technical report.

Assessment reports are broader in scope than surveillance reports. An assessment report usually combines the results of several related surveillance actions and of related and independently conducted engineering surveys to identify discrete compliance deficiencies as well as trends. Assessment reports are the primary tool used to formally issue findings to APSC for corrective action. Most assessment reports are highly technical. They identify problems and their causal factors in sufficient engineering detail to allow APSC to develop corrective action programs of equivalent detail and sophistication. These correction action plans, as well as their proposed implementation schedules, are formally approved by the JPO. The status of a JPO-approved corrective action is evaluated during subsequent surveillance or assessment actions as a way of "closing the loop."

Technical or engineering reports are also utilized; they constitute the most flexible tool in the comprehensive monitoring program tool kit. These reports address issues of a highly technical nature, for which scientific or engineering judgment and documentation of calculations or rationale for professional opinion are required. Some of these reports also include or are accompanied by surveillance reports that document aspects of the issue that were addressed by verification, observation, or documentation. Many engineering reports provide the technical basis for assessment reports. However, engineering reports can also be used independently to identify findings and compel corrective action. Engineering reports are available for review by JPO stakeholders; because they are highly technical, however, they are normally not widely distributed.

The culmination of JPO oversight is the periodic issuance of a full comprehensive monitoring program report. These reports focus on providing summary information to TAPS stakeholders (i.e., federal and state policymakers, the public, and Congress). The reports incorporate the findings and conclusions of previous assessments (including information on any follow-up actions) and previous comprehensive monitoring program reports, thus providing a more comprehensive description of the status of particular items or systems over a longer time period.

4.1.1.5 Corrective Actions Requiring Memoranda

Occasionally a large or longer-term corrective action is identified (e.g., “leak through”[1] on some main-line valves). Such large or potentially expensive repair issues may be addressed through a specific MOA between the JPO and APSC. The MOA will address time frames for correction and other aspects of the corrective action effort arrived at through negotiation (JPO 2002a).

4.1.1.6 The JPO’s Interpretation of “Compliance”

The terms “noncompliance,” “aspects of noncompliance,” and “stipulation deficiency” are used virtually interchangeably in various JPO reports to describe an existing condition that needs to be modified to fully comply with the Federal Grant or State Lease. As applied, these terms may imply, but do not necessarily imply, substantial or immediate threats to human health or safety or to the environment.

The JPO’s use of these terms should not be confused with the level of noncompliance (including a refusal to comply upon notifications of noncompliance) that would be needed to reach the stage of formal Federal Grant or State Lease termination or unilateral modification available under law to the DOI and the ADNR. Rather, these are convenient terms used to inform government policymakers and the public about the issues the JPO is working on with APSC and how the issues relate to the Federal Grant and State Lease. The JPO publishes comprehensive monitoring program reports that summarize APSC’s overall compliance status in specified program areas (JPO 1998a,b; 1999a,b; 2001a,b,c).

TAPS compliance is an ongoing process that involves the following activities:

- Establishing clearly defined requirements and performance standards related to design specification or operations;
- Making field checks with the aid of comprehensive surveillance checklists;
- Where needed, providing notifications of immediate safety, environment, or integrity issues to APSC for corrective action;
- Reviewing and authorizing actions proposed by APSC;
- Tracking activities and facilities’ surveillance observations over time to establish trends;

[1] As used here, “leak through” means the incomplete sealing of a closed valve that results in fluid continuing to flow through the valve.

- Conveying these trends to APSC through assessment reports and compelling corrective actions, where necessary; and
- Summarizing overall compliance status through comprehensive monitoring program reports to stakeholders.

4.1.1.7 Reliability-Centered Maintenance — JPO Oversight into the Future

The JPO recognizes that the TAPS has thousands of moving parts and operates under critical internal and external influences. If not operated and maintained properly, catastrophic injury to people and damage to the environment could result. Because the JPO believes that the useful life of the TAPS (i.e., how long it can operate safely) is directly related to the quality and effectiveness of system monitoring and maintenance, it asked APSC to review its asset maintenance management (AMM) program and to conduct a series of reliability-centered maintenance (RCM) analyses.

The RCM analyses identify maintenance strategies necessary to preserve operational safety and reliability. On the basis of this information, a customized preventive/ predictive maintenance strategy is designed. The goal is to identify potential maintenance problems and prevent them by focusing maintenance efforts on the systems and subsystems associated with the highest risks and biggest consequences.

The RCM initiatives provide a very strong maintenance-based methodology for evaluating current maintenance strategies and the resulting useful life capacity of the TAPS.

The RCM process describes actions necessary to prevent a particular failure or reduce the likelihood and consequences of its occurrence. For example, slope stability and its effects on the integrity of VSMs are currently being studied under the RCM process. The JPO has issued a special requirement for slope stability monitoring that formally incorporates static and dynamic factor performance standards into acceptable safety criteria. APSC's incorporation of this requirement into its monitoring and maintenance protocols will ensure that the safety criteria are always satisfied.

In some situations, a failure management policy cannot be identified for a particular failure mode. In these cases, if the consequences of the failure affect safety or the environment, then the default decision is as follows: "Redesign is compulsory." Compulsory redesign recommendations fall into three categories: modify hardware, modify procedures, or modify training. The JPO is most concerned with implementing the tasks identified by APSC as addressing failures classified as hidden, safety. or environmental. The JPO will also review the manner in which APSC has addressed the compulsory redesign recommendations. This procedure adds a great deal to the government's confidence in the long-term operational viability of the TAPS.

4.1.1.8 Coordinated Planning and Response to Abnormal Incidents

The final JPO focus area relates to the JPO's responsibility to ensure a coordinated and effective response by APSC and all government entities to unplanned incidents that could result in a release of crude oil, refined petroleum product, or hazardous materials into the environment. Since the incident when crude oil spilled from the Exxon Valdez into Prince William Sound, the JPO approach to spill response preparedness has been comprehensive and holistic. It has involved all JPO member agencies in myriad comprehensive planning activities that have resulted in a unified spill preparedness and response plan for the TAPS. In accordance with the National Oil and Hazardous Substance Pollution Contingency Plan (commonly referred to as the National Contingency Plan or NCP; 40 CFR Part 300) and Alaska State statutes and regulations (principally 18 AAC Part 75), the EPA and ADEC are the lead federal and state oil spill response agencies. However, depending on the resources

Ensuring a Safely Maintained TAPS into the Future — Reliability-Centered Maintenance

Seven analytical questions form the core of the RCM process:

- What are the functions of an item of equipment?
- How can it fail?
- What causes it to fail?
- What happens when it fails?
- Does it matter if it fails?
- Can anything be done to predict or prevent the failure?
- What should be done if the failure cannot be predicted or prevented?

Failure modes and the ramifications of a failure are further defined by asking:

- Have failures historically occurred?
- Are they likely to occur?
- Are current maintenance activities preventing failures?
- Are there significant safety or environmental consequences associated with the failure that have not yet occurred but that require proactive measures to be avoided?

The potential effects and consequences of failures are enumerated in detail. The RCM analyses classify failures according to their consequences, as follows:

- Hidden: Has no direct impact; the failure remains unknown until another failure occurs, but it exposes the organization to serious, often catastrophic, consequences if multiple failures were to occur.
- Safety and environmental: Has safety consequences if it could injure or kill someone; has environmental consequences if it could breach an environmental standard.
- Operational: Affects operations by impacting output, product quality, customer service, or operating costs, in addition to affecting the direct cost of repair.
- Nonoperational: Affects neither safety nor production; involves only the direct cost of repair.

The RCM process describes tasks needed to prevent a particular failure or reduce its likelihood of occurring. In some situations, a failure management policy cannot be identified for a particular failure mode. If, in these cases, the consequences of the failure would affect safety or the environment, the default decision is “redesign is compulsory.” Compulsory redesign recommendations fall into three categories: modify hardware, modify procedures, and modify training.

The JPO is most concerned with tasks identified to address failure modes when the consequences of failure are classified as hidden, safety, or environmental, and will track implementation of those tasks. The JPO will also track the resolution of the compulsory redesign recommendations. Application of the RCM methodology as a maintenance strategy substantially increases the government’s confidence in the long-term operational safety of the TAPS.

Suggested Reading:*

Moubray, J.M., 1997, *Reliability-Centered Maintenance*, 2nd Ed., Industrial Press, Inc., New York, N.Y.

NAVAIR 00-25-403 Guidelines for the Naval Aviation Reliability-Centered Maintenance Process, published by Direction of Commander, Naval Air Systems Command, Feb. 2000, available at http://www.nalda.navy.mil/rcm/403manual.pdf.

The following Web sites:

http://www.reliability-centered-maintenance.com/
http://www.aladon.co.uk/
http://www.wara.com/AssetManagement/Asset.html
http://www.nalda.navy.mil/rcm

affected or threatened by the spill, numerous other federal and state agencies can have authorities with regard to oil spill prevention (including leak detection and safe conduct of operations) and preparedness (including both equipment and trained personnel), as well as authorities with regard to overseeing the cleanup of spilled oil or hazardous materials and the restoration of affected resources. These agencies include the BLM, U.S. Department of Transportation Office of Pipeline Safety (DOT/OPS), ADF&G, and ADNR. In addition, other agencies that may be potentially involved include the U.S. Coast Guard (USCG) Marine Safety Office in Valdez, USFWS, and two Alaskan state agencies: the Division of Governmental Coordination and the Department of Labor and Workforce Development.

The common goal unifying all of these agencies is to prevent spills to the greatest degree possible while also ensuring the highest possible levels of spill response preparedness and capability within APSC and participating federal and state government agencies. Because of the myriad of jurisdictional and regulatory requirements that exist among the federal and state agencies, only a coordinated approach involving all agencies can guarantee effective and efficient spill prevention, planning, and response. Within the JPO, a standing committee, the Oil Spill Prevention, Preparedness, and Response (OSPPR) Coordination Team, was formed and charged with coordinating all agency activities in order to prevent unnecessary duplication, promote increased efficiency, and improve the overall capability to meet the common goal.

The scope of the OSPPR Team's charter is broad and includes the continuous review, updating, and refinement of the government's unified spill response plan; review of APSC's spill response plans for its conformance with applicable federal and state substantive requirements; oversight of APSC spill prevention efforts (including leak detection and preventative maintenance programs); oversight of APSC's level of preparedness (including inspections of spill response equipment and reviews of exercises, drills, and personnel training); and continuous reviews of spill response technology developments and of evolving response strategies with regard to their possible incorporation into JPO and/or APSC response plans.

4.1.2 Design Features as Mitigation

4.1.2.1 Design Elements

Numerous TAPS design features actually serve as mitigation measures; they were incorporated into the TAPS to mitigate anticipated impacts. Others were initiated by JPO directives or in recognition of applicable standards or regulations. Major mitigating design features include special installation techniques and foundations; corrosion control features; earthquake mitigation measures; special design considerations for river crossings; volatile organic chemical control; ballast water treatment at the Valdez Marine Terminal; TAPS valves (RGVs and check valves) as mitigation features; main-line TAPS Leak Detection Systems; and special designs for designated big game crossings (DBGCs). Each of these design features is discussed in the sections below.

4.1.2.2 Special Installation Techniques and Foundations

The construction and operation of a buried warm-oil pipeline could induce thaw in permafrost soils. Such thawing might degrade system integrity. Different soil types vary widely in response to thawing. Granular soils with little excess ice are considered "thaw-stable" because they do not lose significant volume or strength when thawed. Fine-grained, ice-rich permafrost, however, may decrease in volume a great deal upon thawing and have a very low shear strength during and after thaw. Subsidence of the ground surface, downslope movement of the thawed mass, and susceptibility to liquefaction can result. These soils are considered "thaw-unstable."

Warm oil flowing in a buried pipeline results in thawing of permafrost and creation of a "thaw bulb" around the pipe. The thaw bulb grows with time at a rate affected primarily by the temperature of the pipe, the temperature and water content of the surrounding soils, and the climate, but eventually it stabilizes. Special designs were developed to deal with the problems imposed by the subsurface conditions and climate. Stipulation 3.3.1 sets criteria that govern which construction mode is used at any given location.

4.1.2.2.1 Conventional Buried Pipe. In areas where the ice content of the permafrost is very low or absent, or where no permafrost exists, the pipe is buried in a conventional belowground mode (see Figure 4.1-1). Three hundred seventy-six miles of TAPS pipe are buried in this manner.

4.1.2.2.2 Buried-Pipe Animal Crossings. As required by Stipulation 2.5.4.1 of the Federal Grant, to ensure free passage of big game animals, buried-pipe animal crossings are provided where there would otherwise be long uninterrupted sections of aboveground pipe. The animal crossings typically consist of about 50 ft of buried pipe in thaw-unstable soils. The buried pipe has an insulated jacket and is installed in an insulation-lined trench. In some instances, refrigeration systems cool the surrounding soil to prevent thawing.

4.1.2.2.3 Special Burial. At three locations, sections of the pipeline are buried in a “special burial” (refrigerated) mode for a total of about 4 mi. This mode involves insulation as well as active refrigeration of the soils in thaw-unstable permafrost. Refrigerated brine lines are installed under the pipe to keep the underlying ice-rich soils from thawing (see Figure 4.1-2).

4.1.2.2.4 Insulated Box. In a few places, at locations where the underlying soils are thaw-unstable, the pipe is installed in an insulated box. This mode is used primarily where avalanches would threaten the pipe if it were aboveground.

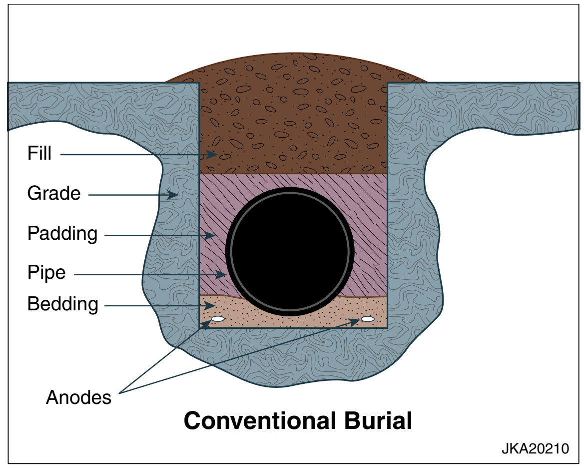

FIGURE 4.1-1 Typical Pipeline Details for Conventional Burial (Source: TAPS Owners 2001a, Figure 4.2-2)

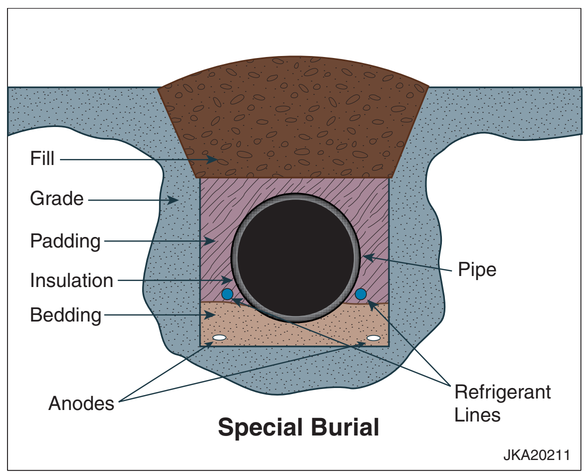

FIGURE 4.1-2 Typical Pipeline Details for Special Burial (Source: TAPS Owners 2001a, Figure 4.2-3)

4.1.2.2.5 Conventional Elevated Pipe. In areas where soils are typically thaw-unstable and thus unfavorable for conventional burial, the pipe is elevated on crossbeams attached to VSMs. Figure 4.1-3 displays a typical VSM installation. The VSMs consist of 18-in.-diameter steel pipe embedded deep enough to support the loading and resist frost heave. Several types of VSMs are used; each is designed for extant soil and loading conditions.

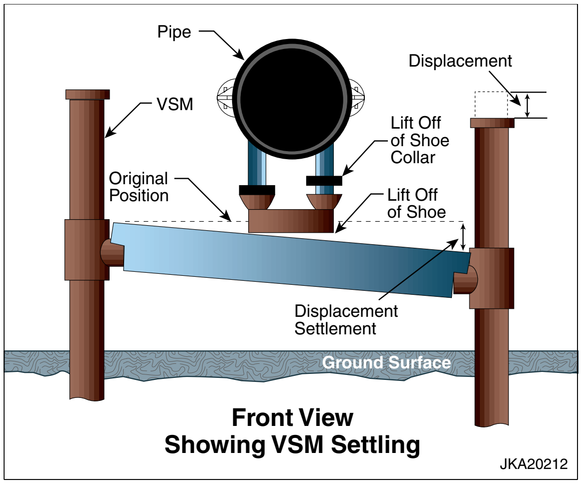

FIGURE 4.1-3 Potential Vertical Support Member Movement (Source: TAPS Owners 2001a, Figure 4.2-5)

South of the Brooks Range, designers expected a high potential for thawing of the permafrost around the VSMs, thus leading to potential instability. Movement of VSMs caused by settling or jacking can cause the crossbeam to tilt or to move up or down at one support relative to adjacent supports (see Figure 4.1-3), either movement of which may cause nonuniform loading of the pipeline. Tilting of VSMs because of settling or lateral earth pressures may also cause the crossbeam to move longitudinally (relative to the pipeline axis), preventing the shoe from being evenly supported by the crossbeam. To avoid this instability, many VSMs are equipped with thermal devices called heat pipes (or thermo-siphons), which use nonmechanical circulation of ammonia in a pressurized tube to remove heat from the soil during winter when the air is colder than the soil. Figure 4.1-4 shows a typical heat pipe cross section.

4.1.2.2.6 Other Facilities. Numerous other facilities associated with the TAPS have foundations in permafrost. These include refrigeration plants, the fuel gas line, pump station facilities, storage buildings communications sites, and others. As required by Stipulation 3.9.1 of the Federal Grant, foundation designs for these structures include active and passive refrigeration in thaw-unstable soils and more conventional designs in thaw-stable soils. The fuel gas line is buried in cold permafrost throughout its length, and the temperature of the gas is regulated to keep it below freezing. (Gas discharged to the line at PS 1 is approximately 20°F.) The gas temperature equilibrates to the temperatures of soils surrounding the pipe as it travels south. Soil temperatures along the gas line vary between –20°F to +32°F annually. The line was constructed in winter from an ice road, and there is no associated workpad.

Heat Pipes

The heat pipes operate in accordance with basic laws of thermodynamics. The anhydrous ammonia inside the sealed heat pipe absorbs heat from the surface soils. The ammonia boils, and the vapors rise to the aboveground portions of the heat tube by differential pressure. There, heat is transferred to the ambient atmosphere and radiated into space. Fins on the uppermost portion of the heat pipes increase the efficiency of this heat exchange. Once the ammonia has released sufficient heat, it condenses and returns back to the bottom of the heat pipe as a liquid, where it is again available for the next heat transfer cycle. Because the heat pipes are sealed, their function does not result in any release to the environment other than heat. Heat pipes can function with limited maintenance or refurbishment. However, corrosion inside the heat pipe as well as the buildup of hydrogen gas from the chemical reduction of residual cutting oils by the ammonia will ultimately reduce the efficiency of a heat pipe to a degree at which it must be replaced. On those occasions, repair and refurbishment procedures call for venting the ammonia to the atmosphere. However, amounts of ammonia in each heat pipe are small — on the order of 14 ounces (Sweeney 2002).

4.1.2.3 Corrosion Control Features

Cathodic protection technologies are employed to mitigate corrosion of buried main-line pipe. Both impressed-current and sacrificial

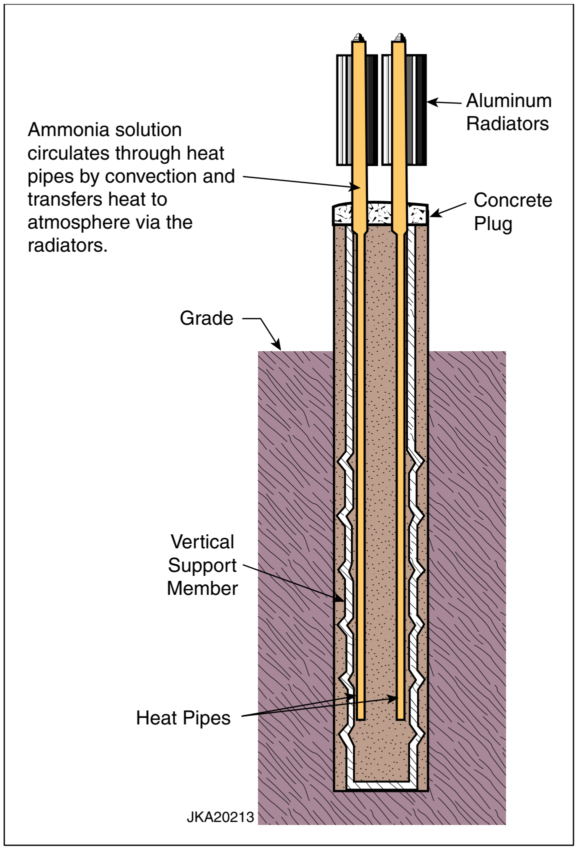

FIGURE 4.1-4 Typical Thermal Vertical Support Member (Source: APSC 2001j as cited in TAPS Owners 2001a, Figure 4.2-6)

galvanic anode technologies are used. Cathodic protection systems are also installed at each pump station and are used to also provide protection to adjacent segments of buried pipe. APSC monitors cathodic protection by "coupon" testing,[2] close interval survey, and test stations positioned along the ROW. Inhibitors are used to control corrosion in isolated and low-flow or seldom-flow piping in pump stations and valves. Monitoring of cathodic system performance is discussed in Section 4.1.3.2.1.

Impressed current systems are utilized in those buried pipeline segments where electrical power is readily available. At remote sites, where commercial power is not available, a

Corrosion Control

All metallic objects are subject to corrosion when exposed to the elements. Corrosion is an electrochemical reaction in which metal atoms loose electrons to form stable ions; that is, they oxidize. The metal acts as the cathode (a source of electrons) in a galvanic cell. (A galvanic cell is a device in which electricity is produced through chemical reactions.) In the case of the pipeline, the iron pipe changes chemically from the metallic state, Fe^{0}, to Fe^{+2} or Fe^{+3} ions that combine with available oxygen atoms to form stable oxides of iron, ferrous oxide (FeO), and ferric oxide (Fe_2O_3), commonly referred to as rust. If left unchecked, this oxidation will continue until so much of the iron in the pipe oxidizes that the pipe's integrity is compromised. All efforts to control the oxidation of the iron in the pipe are generally referred to as "corrosion control" or "cathodic protection." These efforts can involve coating the iron with a material that will isolate it from water and oxygen, or the use of techniques designed to prevent or slow the metal's oxidation reactions. Two such common techniques include the use of a "sacrificial anode" or the application of "impressed electrical current." Sacrificial anodes composed of magnesium metal are buried with the pipeline and electrically "bonded" to the pipe. Magnesium oxidizes more readily than iron and will oxidize completely before the iron pipe begins to oxidize. That is, the magnesium anode is "sacrificed" to save the pipe. Normally, sacrificial anodes will last decades before they need to be replaced. A second way to stem oxidation of the pipe is to apply an electrical current to the pipe that is at least equal to the current that would result from the iron's oxidation, commonly referred to as an "impressed current" cathodic protection system.

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2 As used in the content of the TAPS, corrosion coupons are made of the same metal as the pipeline. They are buried in the pipeline trench; however, they are neither electronically "bonded" to the pipeline nor connected to the corrosion control system.

generator is used to provide electrical current to the impressed current system, or, alternatively, a sacrificial anode system is employed.

Impressed current systems also involve the installation and maintenance of deep-well anodes (also known as vertical anodes), linear anodes, or horizontally distributed anode beds that serve as electrical ground paths. Deep-well ground beds consist of electrically conductive metal rods that were installed vertically from the surface and may be several hundred feet deep. Vertical ground beds are necessary in areas where the electrical resistivity of surface and near-surface soils is high. Because of existing soil conditions in the ROW, some deep-well ground beds were originally installed in locations remote from the pipeline (i.e., off the ROW). Linear anodes were placed near the pipeline at relatively shallow depths. Trenching near the pipeline was required for initial installation, although some linear anodes were installed in the main pipe trench. Horizontally distributed anode ground beds were installed at pump stations; they support not only pump station equipment but also pipeline segments on either side of the station. Horizontal anodes are buried relatively near the surface in proximity to the pipe; they usually have a longer linear extent than a deep-well ground bed in order to ensure an adequate electrical ground path. Regardless of the anode type employed, all impressed current systems also require an electrical power rectifier and rheostat to control current output.

4.1.2.4 Earthquake Mitigation Measures

The TAPS ROW crosses five seismically active zones having Richter magnitudes from 5.5 to 8.5. Section 3.4 provides a description of earthquake potential along the TAPS route and the Valdez Marine Terminal and includes a detailed discussion of the potential impacts of seismic activity on the integrity of the pipeline and Valdez Marine Terminal. Stipulation 3.4.1.1 of the Federal Grant sets criteria governing the design features to mitigate the effects of earthquakes and fault displacement. A design earthquake magnitude has been established for each seismic zone, resulting in unique design parameters (i.e., ground motions and design response spectra) for each zone (APSC 1973).

The pipeline, pump stations, terminal facilities, RGV facilities, and control and communication systems were originally designed to withstand the effects of earthquake ground shaking and permanent ground deformation. In addition, the tanker loading berths at the Valdez Marine Terminal have been designed for estimated maximum tsunami wave and wave run-up conditions that can be expected at Jackson Point (Stipulation 3.7). Where possible, the pipeline was routed to avoid areas having significant potential for large amounts of ground displacement; otherwise, the pipeline was engineered to accommodate permanent ground movements without rupture. At the three fault crossings — Denali, McGinnis Glacier, and Donnelly Dome — the pipeline was placed above ground with oversize pipe shoes and support beams to accommodate design movements. To accommodate extraordinarily large design movements of 20-ft horizontal slip and 5-ft vertical slip at the Denali Fault crossing, the pipeline was placed on beams embedded in a gravel berm. The designs of these fault crossings have been reevaluated and have been confirmed as adequate.

4.1.2.5 Special Design Considerations for River Crossings

The pipeline crosses 80 major rivers in either buried or aboveground mode and is in or adjacent and parallel to a number of river valleys. In accordance with Federal Grant Stipulation 3.6.1.1, these crossings were designed to accommodate foreseeable erosion, scour, ice conditions, and river meanders. Pipeline design at river crossings and in floodplains was based on quantitative assessments of flow and scour and a qualitative analysis of potential channel changes over the life of the system. In addition, the pipeline was designed for the pipeline design flood, a theoretical flood magnitude computed for every significant river and creek crossing in satisfaction of Federal Grant Stipulation 3.6.1.1.1.2.

To mitigate the effects of natural events, channel flow and flood data are incorporated into the initial design of river crossing structures, and flood remediation and contingency plans are developed. Gravel bags or riprap are stockpiled at a number of locations along the ROW, and constant monitoring and inspections of the river crossings are carried out, as are extensive postflood inspections. Also, river training structures are installed and maintained to control the effects of natural bank scouring or the impacts of channel migration on the integrity of buried pipeline segments and pipeline structural support systems.

4.1.2.6 Volatile Organic Emission Control

Certain crude oil handling activities have the potential to release volatile organic compounds (VOCs). Storage tanks and equipment are vented for fire and overpressure safety reasons, and the VOCs released could be emitted to the atmosphere. Major sources of crude oil vapor emissions are controlled through vapor recovery systems at PS 1 and the Valdez Marine Terminal. At PS 1, a vapor recovery system routes displacement vapors from the two receiving tanks (tanks 110 and 111) to a vapor incineration flare. The tanks receive crude from the various North Slope production areas. The tanks also function as crude breakout or pressure-relief (surge) tanks when crude has to be diverted during pipeline upsets or slowdowns. The vapors are collected in a common vapor header and routed to the tank-vapor incineration flare. During 1994 to 1995, APSC installed a new flare tip and a gas-assist combustion system. This upgrade helped improve the combustion characteristics of the flare in all cases except during full tank in-rush situations, when exceedances of the permitted opacity limit still occasionally occurred. In September 2001, APSC installed additional improvements that allowed the flare to accept a full in-rush of volatiles and destroy them without exceedances of opacity limits. ADEC officials witnessed the testing (Montgomery 2002).

The Valdez Marine Terminal is equipped with a system that controls the crude oil vapors from both the onshore tank farm and the marine loading operations. Crude vapors are generated when fresh crude enters the tanks and displaces an equal volume of the internal tank vapor space. The tank displacement vapors are controlled by low-pressure vapor collection lines and are primarily used for vapor balancing to replace tank vapors when tanks are being emptied. Excess tank vapors are used as fuel gas in the Valdez Marine Terminal power boilers. Excess vapors that are not used as fuel are incinerated in one of the three vapor incinerators.

The tanker vapor control system operates in a similar fashion to capture vapors during tanker loading operations at two of the four existing tanker berths. It was built and tied in with the existing system in 1997.

4.1.2.7 Ballast Water Treatment at the Valdez Marine Terminal

Oily ballast water from tankers and other wastewaters from the Valdez Marine Terminal are treated at the BWTF. When it was originally built in 1976, as required by Section 23B of the Federal Grant, the BWTF used three 18,000,000-gal steel primary gravity-separator tanks and six 240,000-gal secondary dissolved-air-flotation cells to remove oil before discharging the saline ballast water to Port Valdez under the terms of a NPDES permit. The waste discharge limitations imposed on the BWTF in the NPDES permit were later revised to include a limit on BTEX. In response, two aerated impound basins were replaced in 1990 by a permanent biological treatment facility

BTEX Fraction

Benzene, toluene, ethyl benzene, and xylene are all discrete polar organic compounds routinely present in crude oil as well as refined petroleum products. Collectively, these four compounds make up what is referred to as the BTEX fraction of the petroleum substance. The BTEX fraction can often be used to identify the chemical “fingerprint” of crude oil or refined petroleum products and is the fraction that normally exhibits the greatest mobility in the environment.

consisting of two 5,500,000-gal concrete aeration tanks equipped with a submerged-jet aeration and mixing system (Rutz et al. 1991). To provide additional reliability, a polishing air stripper was installed downstream of the aeration tanks to remove occasional spikes of BTEX in the event of biological upset (Rutz et al. 1992). The entire BWTF is controlled by a computerized supervisory control and data acquisition (SCADA) system in a centralized control room. Additional discussions regarding wastewaters delivered to the BWTF and the amount and character of discharges from the BWTF to Prince William Sound are provided in Section 3.16.

4.1.2.8 TAPS Main-Line and Pump Station Valves as Mitigation Features

Valves controlling the operational functions of the TAPS are located on the main line, in pump stations, and at the Valdez Marine Terminal. Main-line pipeline and pump station valves have three purposes: minimize spills in the event of a leak in the main line, prevent overpressurization of the pipeline, and isolate pump station and terminal facilities. Valve placement along the ROW was dictated by a number of factors in addition to operational demands, including these two: the locations of sensitive environmental receptors and the adoption of a design specification that no more than 50,000 bbl of crude oil (static volume — the amount of crude oil spilled after all the pumps upstream are shut down and all the valves are closed) would be released in the event of a guillotine break anywhere along the main line.[3] Current performance standards for main-line valves limit valve “leaks through” to a rate that would not result in an increase over the initial design spill volume (Weber and Malvick 2000; Aus et al. 2000.).

The main-line pipeline valve system of 177 valves includes 63 RGVs[4] and 81 check valves. Where the oil flows uphill, check valves prevent backflow if oil pumping stops, as would occur in response to a known or suspected rupture or break. RGVs prevent flow in either direction. (Check valves are preferred over RGVs on uphill slopes. They serve the same purpose as RGVs but are more economical and, more important, they are less complicated and require less maintenance.)

Nine manual gate valves have been placed near check valve sites to provide more positive isolation when required. They are included for pipeline maintenance and secondary spill response. Battery limit valves make up the final 24 pipeline valves. These gate valves are located on either side of each pump station and ahead of the Valdez Marine Terminal to isolate the station or the terminal from the pipeline in the event of a pump station fire or other emergency.

All main-line valves are subject to annual preventive maintenance to refurbish lubricants and ensure mechanical functionality. In addition, all main-line valves are subject to performance testing to ensure that they maintain their ability to seal off flow (minimum “leak through”) (Jackson and White 2000). This function is the key to minimizing the amount of oil that could theoretically leak from any pipeline segment (Stipulation 3.2.2.1) (TAPS Owners 2001a).

4.1.2.9 TAPS Leak Detection Systems

The TAPS leak detection systems include deviation alarms for pressure and flow rate, line volume balance (LVB) leak detection, and

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3 A maximum of approximately 54,000 bbl was calculated as potentially lost due to a spill from a postulated quillotine break in the pipeline. This amount includes both the dynamic volume (the quantity forced through the break due to pumping action) and the static volume. The static volume is less than the 50,000 bbl limit. See Section 4.4 for detailed discussions of spill scenarios and Table 4.4.1-5 for anticipated spill volumes.

4 One ball valve, at PS 11, performs the same function as the RGVs and is included in the count of 63 RGVs used throughout this report. Some valve reconfigurations also occurred during the rampdown actions for PS 2, 6, 8, and 10. A check valve was installed at PS 6. A battery limit valve was installed in PS 10, but it performs the same function as an RGV.

transient volume balance (TVB) leak detection. Each system capitalizes on unique leak characteristics. The intent is to detect leaks as early as possible and when they are as small as possible to minimize environmental damage. To supplement leak detection systems, regular and frequent visual field observations are performed from both the air and the ground.

4.1.2.9.1 Deviation Alarms. Two types of deviation alarms are used: pressure and flow rate. The leak detection system looks for deviations from preset values or sudden changes in flow or pressure. This tool has been in service since 1977 to rapidly detect large leaks. The leak-loss sensitivity threshold is about 10,000 bbl/d (1% of flow), with a response time of 1 to 5 minutes.

Pressure deviation alarms are based on pump station suction and discharge pressure readings. Approximately every 3 to 4 seconds, the SCADA host computer retrieves pressure readings at each pump station. The current pressure reading is compared with the previous one. A drop in pressure greater than 1% of range generates a deviation alarm, as does a value outside the acceptable range of pressures. This method can detect large leaks between adjacent pump stations and between PS 12 and the Valdez Marine Terminal.

Flow rate deviation alarms are based on readings from each pump station's leading-edge flow meter (LEFM) and the incoming meters at the Valdez Marine Terminal, all of which are scanned approximately every 10 seconds by the SCADA system. Each new reading is compared with the previous one. Any deviation greater than 1% of range causes an alarm to sound. Flow rates outside preset limits also generate an alarm. This method can detect large leaks between adjacent pump stations and between PS 12 and the Valdez Marine Terminal.

4.1.2.9.2 Line Volume Balance. LVB leak detection is based on readings from the custody-transfer meter at PS 1 and incoming meters at the Valdez Marine Terminal. The SCADA computer gathers LEFM readings approximately every 3 to 4 seconds and calculates a real-time average flow rate at each end of the pipeline. With these data, every 30 minutes, the LVB system calculates the average oil volume entering the pipeline at PS 1, the average volume leaving the pipeline at the Valdez Marine Terminal, the changes to the oil inventory in all breakout tanks at the pump stations, and the volumes of oil diverted to and returned from refineries at the North Pole and Valdez.

LVB leak detection compares the relative volumes of oil in and out of the pipeline to detect a leak. If more oil is entering the pipeline than exiting, a leak is declared. LVB is a long-term leak detection system that works well for finding smaller leaks. The leak-loss sensitivity threshold is about 2,000 bbl/d (0.2% of flow), and the response time is 6 to 24 hours. For larger leaks, the system can be used to identify the pipeline segment (section between pump stations) of concern. This system has been employed since just after pipeline start-up.

4.1.2.9.3 Transient Volume Balance. A 1998 enhancement to TAPS leak detection capabilities, the TVB system is a computerized method that uses mathematical models to detect leaks on the basis of field measurements. Every 60 seconds, the TVB system calculates flow characteristics derived from actual field pressures, temperatures, flow rates, and crude oil properties. On the basis of this information, the TVB system can produce a reliable flow-rate model. This information is compared with the actual line flow rates measured by the LEFMs. Deviations between the modeled flow and measured flow indicate potential leaks. This method takes just minutes to detect a spill that the LVB system would take hours to detect. The leak-loss sensitivity threshold is about 4,000 bbl/d (0.4 % of flow). The response time is about 30 minutes, depending on leak size. The system is also used to identify the approximate location of the leak. TVB has become APSC's primary leak detection system.

4.1.2.10 Special Designs for Designated Big Game Crossings

Several Federal Grant stipulations pertain to the conservation of terrestrial mammals and require mitigation of impacts to wildlife associated with TAPS construction, operation, and maintenance. Concern for potential obstruction to the migration patterns and local movements of caribou, moose, and bison resulted in construction of DBGCs (Joint State/Federal Fish and Wildlife Advisory Team 1977). DBGCs constructed as elevated pipes were a minimum of 10 ft high and 60 ft long. Also, many were built as short buried sections (i.e., sagbend crossings) or as long, refrigerated, buried sections. A total of 554 DBGCs were designated along the pipeline in areas known by state and federal biologists to be regularly used by bison, moose, and/or caribou on the basis of traditional use and/or habitat characteristics.[5] Pipeline installation designs in these areas meet the requirements of the DBGCs. Studies in the 1970s and 1980s did not show any indication that large mammals were selectively crossing in these areas; however, it was hypothesized that the DBGCs would be necessary for big game movement during winters with severely deep snow (Carruthers and Jakimchuk 1987; Eide et al. 1986; Sopuck and Vernam 1986a,b; Van Ballenberghe 1978).

4.1.3 Mitigation through TAPS Operational Controls

4.1.3.1 Administrative Controls

In addition to the intrinsic design features discussed above, numerous routine TAPS operations provide mitigation against potential impacts or provide reliable data upon which mitigation decisions are based. Stipulation 1.18 requires APSC to conduct surveillance and maintenance of TAPS sufficient to (1) provide for public health and safety, (2) prevent damage to natural resources, (3) prevent erosion, and (4) maintain pipeline system integrity. Stipulations 1.20 and 1.21 require APSC to take all measures necessary to protect the health and safety of all persons affected in connection with TAPS construction, operation, maintenance, or termination and to operate the TAPS in a safe manner so as to ensure the safety and integrity of the pipeline system. In response to these stipulations, as well as in recognition of the overall program quality objectives of Section 9 of the Federal Grant and Section 16 of the State Lease, APSC has developed numerous formal procedures and operating manuals to control the critical aspects of TAPS operations. Among the operations manuals that have the potential to mitigate impacts are the following:

- Procedure Manual for Operations, Maintenance, and Emergencies (OM-1): Provides procedures for operating and maintaining the pipeline during normal and critical conditions. A similar manual, FG-78, addresses operation of the fuel gas line.
- Quality Program Manual (QA-36): Provides overall policy and guidance for ensuring quality in critical TAPS systems (APSC 1999a).
- Inspection Services Manual (IP-218): Provides inspection procedures for modification or addition to critical TAPS systems.
- TAPS Engineering Manual (PM-2001): Provides overall policy and guidance to engineers who produce project designs for modifications or additions to critical TAPS systems (APSC 2001a).
- APSC Design Basis Update (DB-180): Requires that changes to critical TAPS systems receive prior approval of the APSC engineering standards manager (APSC 2001b).
- System Integrity Monitoring Program Procedures Manual (MP-166): Establishes the manner in which system monitoring data will be collected and interpreted to serve as the basis for maintenance intervention.

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5 The Environmental Atlas locates resources and habitats to be protected (APSC 1993).

- Maintenance System Manual (MP-167): Provides maintenance procedures and detailed checklists for planning and scheduling work, monitoring conditions, measuring maintenance effectiveness, and analyzing equipment reliability (APSC 2001c).
- APSC Surveillance Manual (MS-31): Provides pipeline surveillance procedures for the TAPS.
- Trans-Alaska Pipeline Maintenance and Repair Manual (MR-48): Provides detailed procedures for performing specific maintenance and operation (APSC 2001j).

In addition to the above manuals that address TAPS operations primarily from an engineering perspective, other manuals that incorporate health and safety and environmental protection considerations have been developed. These include:

- Environmental Management System Compliance Manual: Defines corporate environmental compliance policies, establishes business models for each compliance program area, and assigns responsibilities for compliance (APSC 2000b).
- Environmental Protection Manual (EN-43-1): Defines the scopes of various environmental protection programs, assigns responsibilities within those programs, and provides references to implementing procedures and training requirement matrices (APSC 2000a).
- Trans Alaska Pipeline System Environmental Protection Manual, Waste Management (EN-43-2): Provides detailed systemwide guidance for the identification and management of wastes routinely resulting from TAPS operations (APSC 2001d).
- TAPS Corporate Safety Manual (SA-38): Provides guidance and assigns responsibilities for the TAPS safety programs (APSC 2001e).
- Guide for Packaging and Transporting Hazardous Materials/Dangerous Goods by Highway and by Aircraft (HZ-134): Provides a reference guide for the safe and proper procedures for identifying, packaging, marking, labeling, documenting, and transporting hazardous materials/dangerous goods in accordance with DOT regulations (APSC 2001f).

Numerous other programs within APSC also provide mechanisms for identifying and mitigating or preempting potential impacts of planned actions. For example, the centralized control of hazardous material purchases allows potential environmental and safety and health impacts from the use of hazardous materials to be identified and provides the opportunity to identify less problematic alternatives. Section 3.16 provides additional details on this hazardous material control program. Likewise, numerous proposed actions require the input and review of APSC's field environmental generalists and environmental subject matter experts to ensure that environmental impacts of proposed actions are clearly understood and that less disruptive alternatives are identified, evaluated, and selected when feasible.

4.1.3.2 Monitoring, Surveillance, and Maintenance

Numerous routine monitoring, surveillance, and maintenance activities are performed for the purpose of preserving system integrity. Although monitoring and surveillance activities do not

Monitoring and Surveillance

The terms "monitoring" and "surveillance" have distinct meanings. Monitoring implies a measurement and comparison against a predetermined value. Surveillance involves simply a visual observation and interpretation of a system component or existing condition by trained individuals. Both activities have the ability to direct mitigation. However, that distinction notwithstanding, the two terms are used interchangeably within the context of discussions related to mitigation.

themselves constitute mitigation, they do produce reliable data on the current condition of critical TAPS equipment relative to predetermined adequate levels of performance. These data, in turn, support mitigation decisions. Over time, the data can also support trend analyses. Collectively, monitoring data are utilized to predict failures and direct preemptive maintenance or replacement actions. TAPS monitoring, surveillance, and preventive maintenance efforts focus on the following areas: main-line pipeline integrity, corrosion control, bridge monitoring, river and floodplain monitoring, seismic (earthquake) activity, slope stability, glacier surge, fuel gas line, and buildings and structures.

4.1.3.2.1 Main-Line Pipeline Integrity Monitoring. APSC conducts systematic monitoring of the aboveground pipeline support system and belowground pipeline for movements that may jeopardize pipeline integrity. Aboveground segments are monitored by field crews who rebalance pipe loading on VSMs. Belowground monitoring is implemented by field observations, elevation surveys of monitoring rods attached to the pipe, and periodic inspections inside the pipeline with devices called “smart pigs,” which travel through the pipe with the flow of the oil (Figure 4.1-5). Belowground pipeline segments are monitored for movement, deformation, and corrosion.

Smart pigs have been in service since 1989 and have become the primary mechanism for collecting monitoring data on pipeline integrity. Depending on what instrumentation is installed, smart pigs can inspect for wall thinning caused by corrosion, curvature and settlement, deformation, dents, or other anomalies. Large quantities of data are recorded by the smart pigs and used to identify pipeline status and changes in pipeline condition over time and provide the basis for focused, preventative maintenance decisions. Since their introduction in 1989, as the quality of pig data (especially wall thickness measurements that are primary indicators of corrosion) has steadily improved, the use of smart pigs has dramatically reduced the number

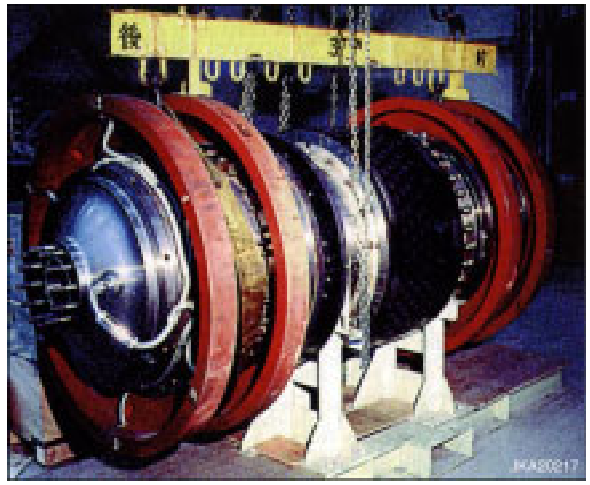


FIGURE 4.1-5 Smart Pig (Source: TAPS Owners 2001a, Photo 4.2-2)

of exploratory corrosion digs. Corrosion pigs were used to inspect the full length of the pipeline in 1994, 1996, 1997, and 2001 (Cederquist 1999; Shoaf 2002). Currently, corrosion pigs are run on a triennial schedule, followed by one curvature pig run in the following year, and one deformation pig run in the next year. Corrosion pigs are also used in the fuel gas line at least once every 10 years. Since start-up, 56 corrosion, curvature, and deformation pigs have been run through the pipeline (TAPS Owners 2001a).

Corrosion Control System Monitoring. All activities related to corrosion system monitoring and maintenance are outlined in APSC’s Corrosion Control Management Plan (APSC 1999b). Monitoring of corrosion control systems involves a number of activities, including data gathering by smart pigs, field inspections and monitoring of impressed current systems, measurements of soil resistivity and other geophysical characteristics and pipe-to-soil potential, and monitoring of corrosion coupons.[6] Resulting data are incorporated into the Corrosion Data Management System, a relational database that is used to ensure adequate corrosion system performance, direct maintenance and repair actions, and identify

6 The rates of corrosion of the coupons are routinely monitored in order to measure the effects of circumstantial factors, such as telluric currents established by the earth’s magnetic fields, on pipe-to-soil potential.

segments where supplemental cathodic protection is required.

Cathodic protection monitoring of the mainline pipeline takes place annually. Data are gathered from test stations, over-the-line (electrical) potential surveys, buried corrosion coupons, cased road crossings, the Atigun reroute, and the fuel gas pipeline (Stears et al. 1998). Gathering of cathodic protection data also occurs at buried propane tanks, pump stations, and the Valdez Marine Terminal. Rectifiers that are present in each impressed current system are checked six times a year. Interpretation of data is performance based rather than being a simple comparison with federal DOT standards. The corrosion control system's performance is judged to be adequate on the basis of its ability to control corrosion, not simply because it meets the DOT standard for amount of current imparted to the pipe. The system routinely exceeds the minimum voltage specified in applicable DOT regulations.

Bridge Monitoring. Bridges for the pipeline, access roads, and workpads provide access for oil spill response, routine maintenance, and equipment for upgrade projects. Professional engineers periodically inspect the bridges for structural integrity and safety. Workpad and access road vehicular bridges are maintained to state highway secondary road standards, and load limits for bridges are posted. Recently, a program to evaluate all vehicular bridges required for oil spill response access was completed. Several bridges were reinforced for projected loads, and several bridges were raised to allow for increased flood flow.

Pipeline bridges were designed to accommodate static and dynamic loadings that include the weight of the pipe, crude oil, insulation, snow and ice, wind, thermal expansion and contraction, and earthquakes. Pipeline bridges are located to provide adequate clearance between the bridge's low chord and the pipeline design flood level and clearance for ice ride-up, aufeis buildup (see text box), and navigational traffic.

The relatively few modifications that have occurred on pipeline bridges have been engineered and documented. APSC monitors pipeline bridge performance through routine surveillance as well as third-party inspections. Currently, there are no known conditions that represent a concern or threat to the integrity of pipeline bridges.

Aufeis

Aufeis is a seasonal accumulation of ice that is superimposed on the frozen surface of a stream or landscape. Aufeis accumulation is common in areas of continuous or discontinuous permafrost. Both surface water and groundwater can be sources of aufeis. Aufeis accumulation constitutes a major management problem for roadways, culverts, and structures that have been located in areas susceptible to ice accumulation, or whose construction impedes water movement in the soil mantle or in surficial channels. Accumulation of aufeis can affect the hydrologic regimen of river basins and can have localized consequences for water quality, fluvial geomorphology, and ecological systems (Slaughter 1990).

Pipeline bridges are inspected annually in accordance with APSC bridge inspection manuals. To evaluate their integrity, a professional engineer registered in the State of Alaska inspects pipeline bridges at intervals not exceeding five years. The purpose of these inspections is to verify that each structure is performing as expected, to note needed maintenance, to notify appropriate personnel of needed improvements, and to serve as an independent monitor to verify the effect of maintenance, design, and construction procedures. Future annual inspections of abutments and piers and five-year inspections of the pipeline superstructure are expected to remain at current levels.

During 1997, inspections were performed on each plate-girder bridge and the Gulkana River Bridge. No significant discrepancies were noted. Because of the lack of access at the Gulkana River Bridge during the 1997 professional engineer's inspection, a full reinspection was conducted in 1999. The Tazlina River suspension bridge was also inspected in 1999. The Tanana River Bridge was inspected in 2001.

Rivers and Floodplains Monitoring. The rivers and floodplains along the TAPS are monitored annually by engineering personnel using aerial photography and on-site evaluations, complemented by weekly surveillance flights by TAPS observers. These observations identify erosion areas and other anomalies or regime changes that may require continued observation and preventative maintenance (see Figures 4.1-6 and 4.1-7). Survey markers have been installed at a number of key locations so that aerial or ground reconnaissance can detect changes (see Figure 4.1-8).

In addition to scheduled annual river surveillance, monitoring occurs during and after floods. In addition, comparative aerial photos are assessed. River engineers use this information to assess the need for preventative maintenance. Detailed river-engineering assessments are undertaken to determine the need for and scope of remedial measures or new structures as a result of major floods. Examples of this are the detailed studies and designs conducted following high flows in 1992 on the Sagavanirktok, in 1994 and 1998 on the Middle Fork Koyukuk, and in 1999 at Marion Creek and in the PS 4 area.

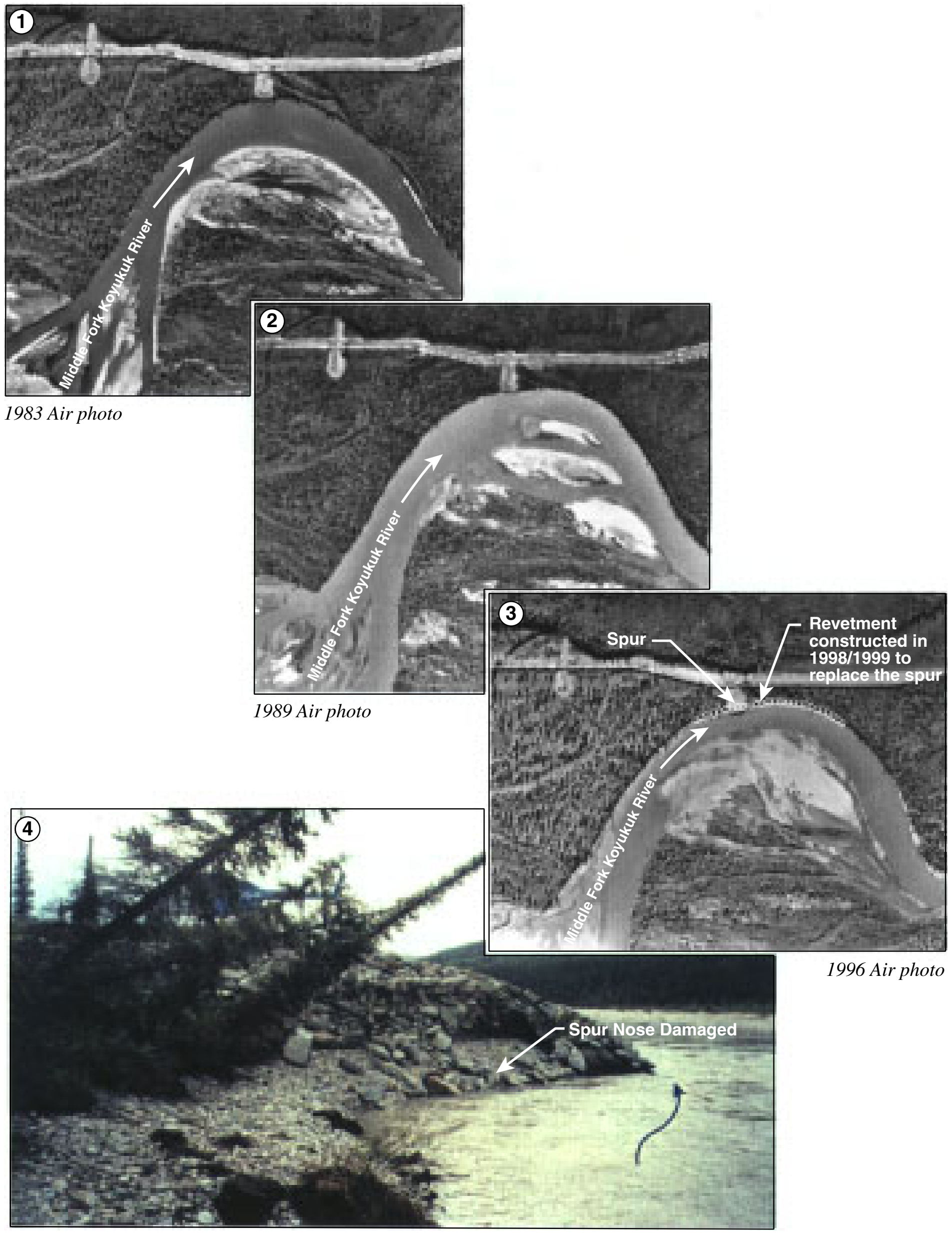
In some instances during high flows, immediate protection measures are taken, such as reinforcing or adding to existing river training structures. More substantial and permanent works, such as new revetments or additional spurs, may also be built. For streams where erosion could potentially impact the TAPS, innovative technologies, such as the Rosgen technique, are being used to train the streams. The Rosgen technique allows control of river or stream erosion with minimal construction and does not require the placement of large dikes or revetments. Preventative measures are performed as necessary to protect the integrity of the pipeline within or near the major river systems as natural channel changes occur.

Seismic/Earthquake Monitoring. An earthquake monitoring system has been part of the pipeline control system since start-up in 1977 (Stipulation 3.4.1.2). The monitoring system consists of 11 remote digital strong motion accelerograph (DSMA) stations located at PS 1, PS 4 through 12 (including the PS 11 site), and the Valdez Marine Terminal. The system processes seismic data to evaluate the severity of earthquake ground shaking and to delineate areas of the TAPS for inspection. Reviews of reports of ground motion caused by the seismic event determines whether the pipeline is shut down and delineates inspection requirements for the affected portion of the route.

The original earthquake monitoring hardware and software were replaced in 1998 with a second generation system. Each station consists of ground-motion-sensing instrumentation (accelerometers) and a computer that provides data acquisition, processing, recording, network communications, and output of alarms to the OCC at Valdez. The pipeline controller determines the need for pipeline shutdown and field inspection by reviewing alarm displays from the earthquake monitoring system and other control system information. Within 10 minutes of when alarms are sounded, shutdown will begin automatically unless the operator intervenes on the basis of his interpretation that the alarm was falsely initiated. The JPO required extensive testing of this shutdown procedure. Deficiencies were identified during these tests and were corrected (Lalla 2001).

Slope Stability Monitoring. About 50 slopes along the ROW were identified during construction as having some potential for mass movements that could damage pipeline facilities. In accordance with Stipulation 3.5.1, these slopes are periodically monitored so that preemptive measures can be taken to prevent the occurrence of, or protect the pipeline against, the effects of such movements. The monitoring includes aerial observations and photography, site inspection, and direct measurements using a variety of instruments. The monitoring results are analyzed and documented, and additional monitoring, instrumentation, maintenance, or repair work is completed as needed.

Glacier Surge Monitoring. In accordance with Stipulation 3.8 of the Federal Grant, glaciers near the pipeline are monitored by aerial photography for movement to ensure adequate notice is provided if a glacier



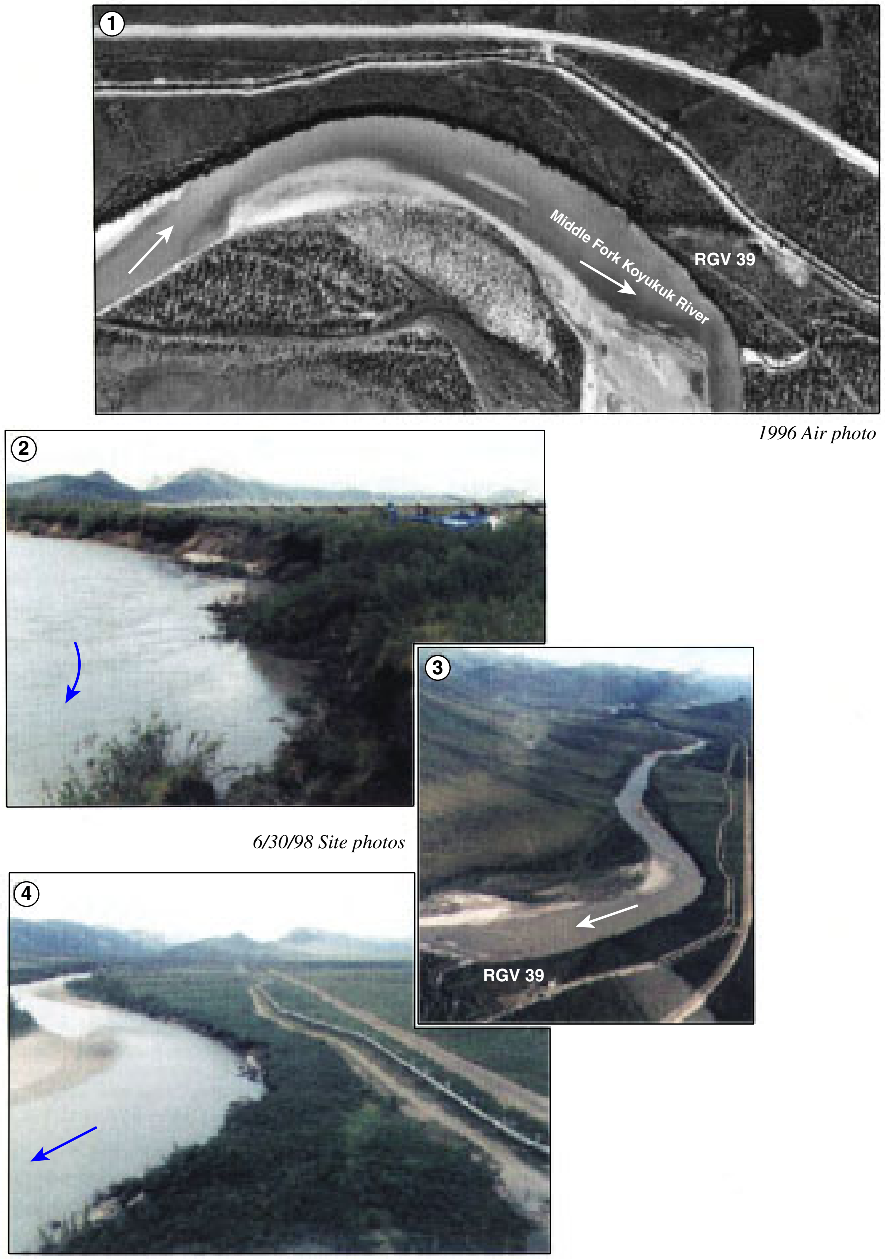
1998 Site photo

At this location, bank erosion towards the spur and elevated pipeline was minor until 1994. A major flood in 1994 necessitated repair of the spur, and high flows in 1998 necessitated construction of a new revetment in the winter of 1998/99. (Compare conditions in Photos 1, 2, and 3). Although the minimum pipeline-to-bank buffer was still about 80 feet in 1998 and the spur (Photo 4) was still partially effective in controlling the rate of and location of the erosion, delaying the work while more erosion occurred would have resulted in minimal pipeline-to-bank buffer and thus would have required "moving" the river (an extensive undertaking) rather than armoring the existing bank.

CONCLUSION: Routine, annual, and event-driven monitoring and follow-up engineering assessments are effective means to establish the need for additional structures and to ensure they are constructed in a timely manner.

JKA20214

FIGURE 4.1-6 Middle Fork Koyukuk River, MP 218, Where Monitoring Led to Follow-up Remedial Action Consisting of Bank Armoring (Source: TAPS Owners 2001a, Figure 4.2-11)

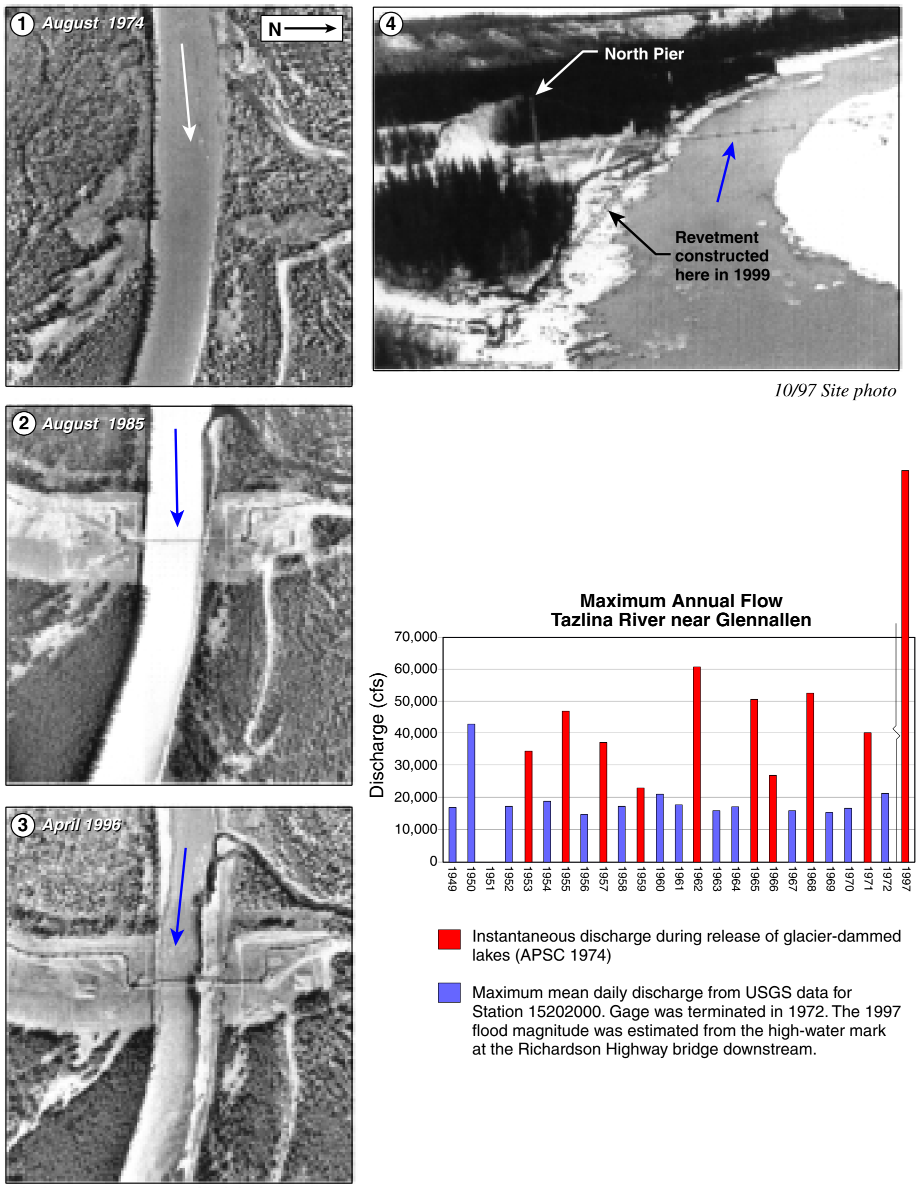


The bank at this large bend is eroding towards the pipeline and RGV 39. The bank was 25 to 30 feet high with a minimum buffer of about 155 feet in 1998. The rate of erosion of the bank, even during major floods, compared to the remaining buffer, did not warrant armoring of the bank at the time of the assessment in 1998. Depending on the timing of the next major flood (the majority of bank erosion is caused during high-flow periods), a revetment may need to be constructed within 5 years, or nothing may be required for 10 to 20 years.

CONCLUSION: Monitoring and assessments can track long-term river changes that may not require immediate remedial measures but warrant close attention on an ongoing basis.

JKA20215

FIGURE 4.1-7 Middle Fork Koyukuk River, MP 217, where Monitoring Did Not Lead to Immediate Follow-up Action (Source: TAPS Owners 2001a, Figure 4.2-12)



Major river crossings such as the 650-foot-long Tazlina River bridge undergo extra monitoring – a video camera on site relays images to a nearby security station. The flood magnitude and potential for river changes on the Tazlina River are related to the release of glacier-dammed lakes, which typically produce flows two times as large as normal peak summer runoff. The flood of record, estimated to be about two times the size of the previous record in 1962, occurred in October 1997 as a result of heavy rains that triggered the release of all four lakes impounded by the Nelchina and Tazlina glaciers. At the centerline of the bridge, a buffer of about 150 feet remained on the north bank after the 1997 flood. Although this buffer would have been adequate for a considerable period of time and probably even the next major flood, and it is considerably more than the total erosion experienced since startup, the potential consequences of another large flood on this major structure resulted in the decision to armor the bank in early 1999.

JKA20216

FIGURE 4.1-8 Tazlina River Bridge, MP 686, Where Monitoring Led to Bank Armoring to Prevent Further Erosion (Source: TAPS Owners 2001a, Figure 4.2-13)

approaches the pipeline or if outburst floods could occur from glacially dammed lakes. Steady movement of a glacier toward the pipeline would result in pipeline relocation. Five glaciers are monitored on a five-year schedule: Worthington, Canwell, Fels, Castner, and Black Rapids. The last monitoring work was completed in 1999 (EMCON Alaska, Inc. 1999). None of the glaciers has advanced since the TAPS was built. Surveillance monitoring continues (Johnson 2000).

Fuel Gas Line Monitoring. Monitoring is performed to verify adequate depth of cover, movement from frost heave, erosion, or ground disturbance. Maintenance or repair is conducted as necessary to restore depth of cover when frost heaves occur. Smart pigs are also used at 5- to 10-year intervals to detect corrosion. As per a DOT/OPS determination, APSC was not required to install corrosion protection on the gas line at the time of installation. However, corrosion has been detected on the pipe near PS 4. APSC is addressing this by repairing the corrosion damage and installing an impressed current corrosion control system at this location. Under a MOA (JPO 2001d), DOT/OPS has provided training to JPO personnel who can then conduct field inspections of the gas line for compliance with DOT regulations (Dygas and Keyes 2002). A smart pig run is scheduled for calendar year 2002. Results will support determination of whether additional gas line segments also need corrosion control.

Buildings and Structures. Buildings and structures at the pump stations and at the Valdez Marine Terminal are monitored to identify movements from permafrost thaw or ground subsidence. The information is used to develop maintenance programs and to arrest ground movement before foundation damage. Some building foundations are equipped with refrigeration systems to prevent heat transfers into the permafrost.

4.1.3.3 Biological Considerations for Operations and Maintenance Activities

Numerous stipulations in the Federal Grant deal with mitigating or preempting impacts on biological systems. These stipulations contain either prescriptive requirements or performance standards that must be met by APSC in the planning, design, construction, operation, maintenance, and eventual decommissioning of the TAPS. Because these stipulations are concerned with impacts on highly dynamic natural systems, they are often written in a manner that requires case-by-case approvals or permits by the appropriate JPO member agency, thereby allowing the agency to fully consider all circumstantial factors existing at the time of the proposed actions. However, when the impacts of proposed actions on biological systems are predictable with reasonable precision, these stipulations either contain specific requirements or defer to the application of relevant rules promulgated by JPO member agencies. Table 4.1-2 lists the relevant stipulations, the topics they address, and their respective requirements and controls.

APSC's response to Federal Grant stipulations that control impacts on biological resources involves numerous initiatives, including (1) development and distribution of corporate policies on interacting with and protecting biological resources; (2) issuance of explicit directives, guidance, and prohibitions to APSC personnel and TAPS contractors; (3) training of APSC personnel about potential impacts on biological resources, including appropriate behavior toward wildlife; (4) posting at facilities or distribution of relevant permits and the TAPS environmental atlas delineating sensitive areas; (5) development of contingency plans that include special consideration for biological resources; and (6) development and implementation of internal administrative

TABLE 4.1-2 Federal Grant Stipulations Related to the Mitigation of Impacts on Biological Systems

Stipulation	Topic	Summary of Requirements or Controls
1.14	Camping, hunting, fishing, and trapping	• Post signage prohibiting camping, hunting, fishing, trapping, and shooting within the ROW. • Prohibit such activities by APSC personnel and TAPS contractors. • Notify employees of applicable regulatory controls over such activities.
2.2	Pollution control	• Do not use mobile ground equipment in or on lakes, streams, or rivers unless specifically approved.
2.23	Thermal pollution	• Comply with thermal pollution standards in Alaska Water Quality Standards.
2.25	Pesticides	• Use only nonpersistent and immobile pesticides, herbicides, and other chemicals. • Obtain written approval from the JPO Authorized Officer for all pesticide usage.
2.4.1	Erosion control	• Conduct all operations in a way that will avoid or minimize disturbances to vegetation. • Ensure that the facility design minimizes erosion.
2.4.2	Stabilization	• Stockpile surface materials taken from disturbed areas and use them during restoration. • Stabilize the site, which can include, but may not be limited to, seeding, planting, mulching, and the placement of mat binders, soil binders, rock or gravel blankets, or structures, as dictated by site-specific conditions and needs.
2.4.3	Erosion control/crossing of streams, rivers, or floodplains	• Prevent or minimize erosion at stream or river crossings or in floodplains. • Ensure that temporary access over stream banks is by means of fill ramps rather than stream bank cutting, unless otherwise approved.
2.4.4	Seeding and planting	• Seed and plant disturbed areas as soon as practicable and, if necessary, repeat until vegetation is successful.
2.5.1	Passage of fish	• Provide for uninterrupted movement and safe passage of fish. • Ensure that any artificial structure or stream channel change includes fish passage features. • Screen (water withdrawal) pump intakes. • Plug and stabilize abandoned water diversion structures to prevent trapping or stranding of fish. • Place levees, berms, or other suitable structures that protect fish and fish passage and prevent siltation at material sites adjacent to or in certain lakes, rivers, or streams.
2.5.2	Fish spawning beds (and fish rearing areas)	• Avoid channel changes in fish spawning beds or rearing areas when possible. • When necessary, construct new channels in accordance with written JPO standards. • Protect fish spawning beds and rearing areas from sediment; intercept any anticipated silt with settling basins before it reaches streams or lakes. • Repair damage to fish spawning beds and rearing areas caused by construction, operation, maintenance, or termination of the pipeline.

TABLE 4.1-2 (Cont.)

Stipulation	Topic	Summary of Requirements or Controls
2.5.3	Zones of restricted activity	• Adhere to restrictions of some activities imposed by the JPO in key fish and wildlife areas during periods of fish and wildlife breeding, nesting, spawning, lambing, or calving activity and during major migrations of fish and wildlife.
2.5.4	Big game movements	• Construct and maintain the pipeline, both buried and aboveground sections, to assure free passage and movement of big game animals.
2.6	Material sites	• Use existing material sites in preference to new sites. • Do not take gravel from stream beds, river beds, lake shores, or other outlets of lakes unless approval is granted by the JPO Authorized Officer. • Ensure that the design and operation of material sites prevents soil erosion and damage to vegetation.
2.7.2.5	Clearing	• Remove debris resulting from clearing operations that may block stream flow, delay fish passage, contribute to flood damage, or result in stream bed scour or erosion.
2.8.1	Disturbance of natural water	• Refrain from taking any action that may create new lakes, drain existing lakes, significantly divert natural drainages, permanently alter stream hydraulics, or disturb significant areas of stream beds (on state land) unless approval of such activities, along with necessary mitigation measures, is secured from the JPO.
2.9	Off-ROW traffic	• Do not operate mobile ground equipment off the ROW, access roads, state highways, or authorized areas unless specific written approval is provided by the JPO or unless such actions are necessary to prevent harm to any person.
2.11.2	Use of explosives	• Do not blast under water or within one-quarter mile of streams or lakes without permits from the ADF&G.
2.12	Restoration	• Restore disturbed areas to the satisfaction of the JPO Authorized Officer. • Leave cut and fill slopes in stable condition. • Dispose of materials from access roads, haul ramps, berms, dikes, and other earthen structures in accordance with directions from the JPO Authorized Officer. • Properly dispose of vegetation and overburden removed during clearing.
3.9.1	Construction and operation; thermal and environmental changes	• Conduct construction, operation, maintenance, and termination activities so as to avoid or minimize thermal and other environmental changes and provide maximum protection to people and to fish and wildlife and their habitats.

TABLE 4.1-2 (Cont.)

Stipulation	Topic	Summary of Requirements or Controls
3.9.1	Construction and operation; thermal and environmental changes (Cont.)	• Plan and execute working platforms, pads, fills, and other surface modifications in such a way that any resulting degradation of permafrost will not jeopardize the pipeline foundations.

controls and procedures. APSC program initiatives that apply to biological resource protection are contained in Section 5 of the TAPS Environmental Protection Manual (APSC 1998b).

APSC's corporate policies[7] with respect to interactions with biological resources are reflected in the following three policy statements in the TAPS Environmental Protection Manual:

- "Alyeska personnel will make all attempts to avoid harming or disturbing wildlife, wildlife habitats, archaeological sites, and fish-containing waterbodies."
- "Feeding, attracting, or unnecessarily disturbing any animal (fish, bird, or mammal) is prohibited at Alyeska facilities and work sites."
- Feeding wildlife may result in disciplinary action, including termination of employment."

APSC has issued the following specific prohibitions to APSC personnel and TAPS contractors:

- Feeding, attracting, or unnecessarily disturbing any animal (fish, bird, or mammal) is prohibited at APSC facilities and work sites.
- APSC personnel may not camp within or hunt, fish, trap, or discharge firearms from the pipeline ROW. The ROW includes related facilities defined as the workpad, pump stations and associated buildings, valves, the fuel gas line, bridges, dikes, the terminal, and all other structures and facilities necessary to operate and maintain the pipeline.
- Feeding bears or prompting actions that create unnecessary intrusion of wild animals at the job site is prohibited.

Finally, various operating plans and internal procedural controls in effect for the TAPS reflect special attention to the protection of biological resources. Successful execution of these procedures relies on the regular involvement of APSC subject matter experts or field environmental generalists. Subject matter experts are stationed at the Fairbanks Business Unit and the Valdez Marine Terminal. Field environmental generalists are stationed somewhere in the portion of the pipeline for which they have been assigned responsibility for environmental protection oversight. Both subject matter experts and field environmental generalists are highly trained in environmental protection tactics (including tactics directed at protecting biological resources) and very familiar with applicable regulations and requirements. They serve as consultants to the APSC work force and help to identify potential impacts on biological resources from planned activities and develop strategies to preempt or mitigate those impacts. Field environmental generalists or subject matter experts must review and approve all proposed actions that have environmental consequences or create compliance liability for APSC. Field environmental generalists and subject matter experts are also responsible for identifying occasions when permits or approvals from JPO agencies are required and for initiating the actions to secure them. Field environmental

7 APSC has indicated that the Environmental Protection Manual, EN-43-1 (APSC 1998b) has been amended and that corporate "policy statements" are now referred to as "environmental work practices." However, there were no substantive changes (Sweeney 2002).

generalists are responsible for ensuring that internal procedures and controls are followed and for continuous surveillance for adverse impacts from TAPS activities. All planned activities that have the potential to affect biological resources are subject to (internal) environmental reviews. Necessary or appropriate actions for protection of biological resources are incorporated into detailed work plans for the activity. These reviews also identify the permits that may be required to support the activity.

4.1.4 Spill Prevention and Response

Many JPO agencies have authorities over spill prevention and response. DOT/OPS regulates pipeline safety and approves contingency plans. The JPO Authorized Officer monitors system integrity and approves spill contingency plans for the pipeline and terminal. ADEC also approves spill contingency plans for their conformance with state requirements.

In 1990, after the Exxon Valdez spill, Alaska enacted legislation that significantly strengthened standards for oil tankers, terminals, pipelines, and oil exploration and production facilities. ADEC amended its regulations under 18 AAC 75, *Oil and Other Hazardous Substances Pollution Control*, accordingly. The new law required, among other things, that spill prevention requirements be added to spill contingency plan rules; that response planning standards be established for different types of facilities; and that ADEC review and approve oil discharge prevention and contingency plans.

Article 1 of 18 AAC 75 addresses pollution control requirements. These include the following:

- Leak detection, monitoring, and operating requirements for crude oil transmission pipelines;
- Oil storage tank requirements;
- Secondary containment requirements for aboveground oil storage and surge tanks;
- Facility piping requirements for oil terminal and crude oil transmission pipeline, exploration, and production facilities; and
- Recommended practices.

Article 4 of 18 AAC 75 addresses response action plan requirements. Article 4 requires that an oil discharge prevention and contingency plan be developed in a form that is usable as a working plan for oil discharge prevention, control, containment, cleanup, and disposal, and that this plan be submitted to ADEC. Article 4 prescribes that these plans have four parts. Part 1 is an emergency response plan in sufficient detail to clearly guide responders in an emergency event. An emergency response plan should include the following:

- *Emergency actions:* A short checklist of the immediate response and notification steps to be taken if an oil discharge occurs;
- *Reports and notification:* A description of the immediate spill reporting actions to be taken at any hour of the day;
- *Safety:* A description of the steps necessary to develop an incident-specific safety plan for conducting a response;
- *Communications: A* description of field communications procedures;
- *Deployment strategies:* A description of proposed initial response actions that may be taken, including procedures for the transport of equipment, personnel, and other resources to the spill site; and
- *Response strategies:* A description of the discharge containment, control, and cleanup actions to be taken.

In addition to these general response plan standards, there are specific standards for each type of facility or vessel to which Article 4 pertains (oil terminal facilities, exploration or production facilities, crude oil pipelines, crude oil tank vessels and barges, noncrude oil tank vessels and barges, and multiple operations).

An oil discharge prevention and contingency plan should also contain a prevention plan in

Part 2 that meets the requirements of Article 1. A prevention plan should include the following:

- A description and schedule of regular pollution prevention, inspection, and maintenance programs in place at the facility or operation;
- A history and analysis of all known oil discharges of greater than 55 gal that have occurred at the facility;
- An analysis of potential oil discharges and a description of actions taken to prevent potential discharges;
- A description of any condition specific to the facility or operation that might increase the risk of a discharge and any measures that have been taken to reduce the risk of a discharge attributable to these conditions; and
- A description of the existing and proposed means for detecting discharges, including surveillance schedules, leak detection, observation wells, monitoring systems, and spill detection systems.

Part 3 of the plan should contain supplemental information that provides background and verification information, including the following:

- A facility description and operational overview that contains a general description of the activities of the operation;
- A description of the receiving environment (for a land-based facility or operation, the potential paths of oil discharges from the facility or operation to open water);
- A description of the command system used to respond to a discharge that must be compatible with the state’s response structure;
- A description of realistic maximum response operating limitations;
- A description of logistical support that might be used to transport equipment and personnel during a discharge response;
- A complete list of oil discharge containment, control, cleanup, storage, transfer, lightering, and related response equipment;
- A detailed description of the training program for discharge response personnel; and
- Mapped predictions of discharge movement, spreading, and probable points of contact with environmentally sensitive areas and areas of public concern.

Part 4 of an oil discharge prevention and contingency plan must provide for the use of the best available technology consistent with the state’s best available technology review and approval criteria (18 AAC 75.445(k)). In addition, Part 4 of the plan should identify technologies applicable to the facility or operation that are not subject to the state’s best available technology review and include a separate written justification that the technology proposed to be used is the best available for the applicant's operation.

On February 2, 2002, the Supreme Court of the State of Alaska entered an order declaring the state’s best available technology approval criteria invalid. ADEC adopted a three-tiered approach for determining whether a contingency plan provides for the use of the best available technology. The first tier of the definition requires cleanup and containment technologies to meet the oil spill response performance standards mandated by Alaska statutes. The second tier of the definition requires that oil pollution prevention technologies, with limited exceptions, be capable of meeting the performance standard of the applicable oil spill prevention regulations. Under ADEC regulations, the technology is considered the best available if it is appropriate and reliable for the intended use, as well as for the magnitude of the applicable response planning standard. The third tier of the definition, which covers remaining technologies not subject to either the cleanup or prevention performance standards, requires each technology to be reviewed on a case-by-case basis using specific criteria. The criteria include whether the technology is the best in use in a similar situation, is available for use by the application, is transferable to the applicant’s operations, and that there is a reasonable expectation the technology will provide increased spill prevention or other environmental benefits. The court found that the first two tiers of the definition were inconsistent with the statutory requirement to have the best available technology, because the regulations would allow any technology that meets the performance criteria and is appropriate and reliable, rather than the "best available technology." The matter has been remanded to the Alaska Superior Court.

Pursuant to 18 AAC 75 and federal regulations, several such plans have been developed. The *Trans-Alaska Pipeline System Oil Discharge Prevention and Contingency Plan* (CP-35-1) (APSC 2001g) covers the main TAPS pipeline and pump facilities. The *Valdez Marine Terminal Oil Discharge Prevention and Contingency Plan* (CP-35-2) (APSC 2001h) covers the Valdez Marine Terminal. The *Prince William Sound Oil Discharge Prevention and Contingency Plan* (Prince William Sound Tanker Plan Holders 1999) covers Prince William Sound. Another relevant document is the *Alaska Clean Seas Technical Manual* (Alaska Clean Seas [ACS] 1999a). To ensure coordinated response by regulatory agencies, a consolidated spill plan was developed by the Alaska Regional Response Team (ARRT), a coalition of government agencies responsible for spill response (ARRT et al. 1999).

4.1.4.1 Pipeline

Operation of the main TAPS pipeline and pump station facilities, beginning at the incoming producer pipeline block valve and ending at the Valdez Marine Terminal property fence, is governed by the *TAPS Oil Discharge Prevention and Contingency Plan* (APSC 2001g). It provides detailed information for reconnaissance, response, and containment actions in the event of an oil spill.

This TAPS Contingency Plan, which is reviewed annually by the BLM, every three years by ADEC, and every five years by DOT, divides the 800-mi pipeline into five regions. (Region 1 extends from MP 0 to 206, Region 2 extends from MP 206 to 357, Region 3 extends from MP 357 to 496, Region 4 extends from MP 496 to 648, and Region 5 extends from MP 648 to 800.) It contains an oil discharge prevention and contingency plan for each region. To facilitate response, the pipeline regions are further divided into contingency areas. Contingency areas are subdivided into segments for containment actions, access, and detailed environmental information. Contingency plans with season-dependent instructions on how to respond to a spill have been developed for segments of contingency areas. Figure 4.1-9 identifies specific sites and equipment for spill prevention and response activities along the pipeline. In addition to BLM, ADEC, and DOT review, the EPA has jurisdiction for facility response plans (pump stations).

In the prevention program in place, the oil transportation and storage facilities and operational systems have been designed to help prevent and minimize oil spills (APSC 2001g). The equipment used to prevent oil release includes these items and features:

- Control system interlocks,
- Main-line valves,
- Redundant system design,
- Secondary containment systems,
- Level gauges, and
- Abnormal condition alarms.

Operational systems in place to prevent and minimize oil spills include these:

- Safe operating procedures;
- Operator training programs;
- Corrosion monitoring and prevention programs;
- Periodic oil spill exercises that range from unannounced, quarterly notification of qualified individuals to triennial entire plan exercises;
- Preventive maintenance programs; and
- Quality assurance programs.

Click here to view Figure 4.1-9

FIGURE 4.1-9 TAPS Oil Spill Contingency Resources

Control of an oil spill can be viewed in four distinct phases: leak detection, source control, containment and recovery, and restoration. The plan provides for the following:

- Equipment and resources and field training for spill responders;
- Electronic leak-detection capabilities;
- Improved leak detection and leak prevention alarm systems for pump station tanks;
- More than 220 sites along the ROW that are designated as staging and deployment areas for oil spill equipment, and dedicated oil-spill-contingency-plan buildings and equipment at each of the pump stations;
- Service contract with Rampart and Stevens Village to provide local guides with Yukon River expertise;
- Thirteen spill scenarios that cover a variety of terrains, oil products, spill volumes, and seasonal conditions; and
- Aerial photographs of the pipeline to aid in spill response planning.

For example, the contingency plan suggests the following tactics in a response to a spill occurring during the summer in Segment 2 (MP 144) of the Atigun River Contingency Area. A spill in this area would occur over land, with subsequent overland flow to the nearby river. Specifics of the contingency plan include:

- Confining the spill to the workpad by constructing berms and barriers from materials from the pump station pad;
- Constructing berms or barriers in front of the leading edge of the spill to prevent oil from reaching flowing water;
- Deploying booms to contain the oil in the ponds, if the oil reaches a pond or ponds west of the pump station, and constructing an underflow dam at CS3-31 (a small drainage at the confluence with the Atigun River west of PS 4) to prevent oil from reaching the Atigun River; and
- Deploying a series of diversion booms downstream from the Dalton Highway Bridge to divert oil to the south bank, if oil reaches the Atigun River.

Any oil that escapes containment by the booms is assumed to form patches of sheen. These sheens would follow river currents downstream. They would evaporate, dissolve in the water column, bind with inorganic silt particles, and be removed from surface water quickly because of vertical mixing.

In addition to detailed response tactics, the TAPS Contingency Plan also describes detailed response strategies for 13 hypothetical spills. These spills are assumed to occur along various sections of the TAPS ROW. The scenarios illustrate the implementation of a range of response strategies within the framework of the response organization and demonstrate how resources will be allocated in the event of a spill. Each scenario addresses the following:

- The discharge itself, including a description of its location, environmental conditions, source, cause, quantity, and environmental sensitivities;
- The notification process, starting with the discovery of the spill;
- The emergency actions taken to stem the discharge;
- Tracking of the discharge;
- Safety measures, including the identification of potential hazards, specification of personal protective equipment requirements, establishment of decontamination (if appropriate), and precautions to be taken to minimize the risk of fire;
- The Incident Commander, who issues the incident objectives;
- Initial response actions, including the resources (persons, equipment, material) needed to accomplish these actions and the estimated time of arrival of the resources;
- Reevaluation of the objectives during the course of the response;

- Longer-term response actions that might be needed to repair the source of the spill, recover free oil, and decontaminate the environment;
- The logistics needed to transport persons, equipment, and materials to the site of the spill; and
- The communications systems needed.

4.1.4.2 Valdez Marine Terminal

Spill prevention and response measures at the Valdez Marine Terminal are explained in the *Valdez Marine Terminal Oil Discharge Prevention and Contingency Plan* (CP-35-2) (APSC 2001h), which has been approved by ADEC. Part 2 of this plan addresses the prevention programs, procedures, requirements, and equipment in place at the Valdez Marine Terminal. These include the following:

- *Preventive training programs.* Oil spill prevention training is given to staff at the terminal (facility operators, maintenance, support services, and project personnel, including contractors) who have direct control or maintenance responsibilities over the oil handling portions of the facility.
- *Substance abuse programs.* Persons at the Valdez Marine Terminal who perform operations, maintenance, or emergency functions at oil handling or transfer facilities, or those who are engaged on board a vessel under USCG jurisdiction, or those who operate a commercial motor vehicle, are subject to a drug testing program designed to meet DOT pipeline safety standards and USCG standards.
- *Medical monitoring programs.* APSC maintains a program of preplacement physical exams and continuing mandatory medical monitoring.
- *Security program.* A security program prevents unauthorized access through measures that include fencing, security guard force patrols, visual inspections and camera surveillance of grounds and equipment, and safety inspections by Valdez Marine Terminal personnel.
- *Transfer procedures.* A number of safe operating procedures have been developed to control transfer and help reduce the risk and size of a spill during transfer operations, such as during the loading or off-loading of fuel and trucks, fueling of tugs and escort vessels, loading and off-loading of tank vessels, and tank-to-tank transfers.
- *Oil storage tanks.* Measures in place to prevent oil spills from oil storage tanks include maintenance and inspection programs, cathodic protection systems, leak detection systems, overfill prevention measures during transfer events, and appropriate oil storage tank designs.
- *Secondary containment.* Secondary containment, consisting of dikes, berms, and walls, has been built around tanks to contain a spill that might result from a spill or rupture in the tanks or connective piping. The area within secondary containment is subject to an integrity maintenance program, is kept free of debris, and is drained of water accumulation.
- *Steel piping corrosion control.* Pipeline integrity is monitored between the metering facilities and the tank farms and between the metering facilities and the loading berth to detect potential leaks. There is also an inspection and cathodic protection program to prevent piping corrosion.

Part 1 of the Valdez Marine Terminal Contingency Plan addresses the terminal's response actions in the event of an oil spill there. It does not address the response to spills from tankers berthed at the terminal. Such spills are responded to in accordance with each tanker's plan and the *Prince William Sound Oil Discharge Prevention and Contingency Plan.* The most likely source of spills at the terminal would be those resulting from maintenance and system integrity problems, such as pinhole corrosion leaks in pipes, improperly installed fittings, leaking gaskets, or valve packings. Other sources of spills would be equipment failure and operator error.

Should an oil spill occur, the terminal has a two-stage response strategy. The first stage is the immediate response. Upon notification that a spill has occurred, the Initial Response Incident Commander would first determine whether any personnel are injured and whether conditions that are potentially harmful to response personnel exist. The commander would then attempt to determine the source of the spill and to control it. Then the Initial Response Incident Commander (or successors – the Initial Incident Commander or Incident Commander) would determine the quantity of oil spilled and the locations impacted. The spill would be reported in accordance with government requirements based on the quantity of the spill and its location. Eight types of positions (Initial Response Incident Commander, Safety Officer, Security Office, Operations Sections Chief, Planning Section Chief, On Land/Water Containment and Recovery, Source Mitigation, and Logistics/ Temporary Repairs) are involved in the initial response stage, each with a checklist of actions.

If a spill requires additional response activities beyond those required in the immediate response, the number of positions with checklists would be increased by 13 (Incident Commander, Operations Section Chief, Open-Water Group Supervisor, Near-Shore Group Supervisor, Shoreline Group Supervisor, Land Group Supervisor, Air Operations Branch Director, Staging Area Branch Director, Planning Section Chief, Environmental Unit Leader, Logistics Section Chief, Fishing Vessel Coordinator, and Finance Section Chief), and the lengths of the checklists are increased.

Several strategies could be used to respond to an oil spill. Each of these strategies for oil on open water has appropriate checklists. These strategies include:

- *Containment and control strategies:* For marine spills, strategies rely strongly on containment booms. When tankers are being loaded, a containment boom is prepositioned around the vessel and held together by a system of permanent and secondary anchors. Should an oil spill occur outside a boomed-off area, a prestaged boom at several locations could be deployed. Land spills are likely to be contained by secondary containment.

  Should an oil spill occur outside secondary containment or overwhelm it, several measures could be taken to contain the spill before it reached Port Valdez. These include blocking culverts, constructing berms or dams, or interposing fences, trenches, and sheet barriers.

- *Dispersants:* Using dispersants may be an appropriate strategy when the oil spill is heading toward sensitive shoreline areas. It would result in less overall environmental impact, and dispersant application is safe for personnel. Depending on where the dispersants are applied, approval must be obtained from either the Federal On-Scene Coordinator.

- *In-situ burning:* This strategy can be used only in certain locations when meteorological conditions are appropriate. In-situ burning operations would be conducted in conformity with ARRT guidelines.

4.1.4.3 Prince William Sound

Spill prevention and response measures for oil spills originating from a tanker vessel at berth or traveling upon state waters of Prince William Sound are explained in the *Prince William Sound Oil Discharge Prevention and Contingency Plan* (Prince William Sound Tanker Plan Holders 1999). Spill prevention and response measures at the Valdez Marine Terminal are explained in the *Valdez Marine Terminal Oil Discharge Prevention and Contingency Plan* (APSC 2001h.)

In Prince William Sound, oil spills can occur while a tanker is in transit from causes such as collisions, groundings, striking floating objects, or impact with a fixed object. They can occur while a tanker is at berth from causes such as berthing or unberthing impact, mooring line failures, structural failure, or during crude oil or ballast water transfer operations.

An important prevention and response resource is the APSC SERVS. One of the missions of SERVS is to prevent oil spills by helping tankers safely navigate through Prince William Sound. SERVS uses five escort response vessels (ERVs) for this mission. SERVS response responsibilities include assisting laden tankers in emergencies and providing an initial oil spill response.

Programs and procedures to prevent spills found in Part 2 of the *Prince William Sound Oil Discharge Prevention and Contingency Plan* include the following:

- *Vessel traffic lanes.* Tankers transiting Prince William Sound from the Valdez Marine Terminal to Cape Hinchinbrook are required by USCG regulations to participate in the USCG VTS. Tankers are required to notify the VTS, maintain communications with the VTS, and maintain vessel separation requirements while in the vessel traffic lanes. Special precautions must be taken when they are within the Valdez Narrows VTS Special Area.
- *Ice navigation procedures.* When glacial ice is observed in the vessel traffic lanes, tankers reduce speed. The VTS may impose custom routing measures to route vessel traffic around ice, as appropriate. If no safe routing exists, Port Valdez is closed to tank vessel traffic.
- *Industry ice management procedures.* When ice is observed or reported in the vicinity, a tanker transiting Prince William Sound in periods of darkness or reduced visibility must be escorted by a vessel with operational radar and searchlights.
- *Maximum transit speeds.* Speeds for laden tankers transiting Prince William Sound are limited by USCG regulations and are monitored.
- *Pilot and watch requirements.* While a tanker is navigating Prince William Sound, at least two licensed officers must be on watch on the bridge pursuant to USCG regulations. In certain areas, there must be a pilot on watch on the bridge.
- *Weather restrictions.* Weather restrictions on tanker traffic at several locations (Port Valdez, Valdez Narrows, Valdez Arm, Knowles Head Anchorage, and Hinchinbrook Entrance) may close traffic or require extra escorts, depending on wind speed and whether a tanker is laden.

The Prince William Sound spill prevention and preparedness program has the following elements. These are listed in order from the perspective of an inbound tanker entering Prince William Sound.

- An inbound tanker ballasted with seawater enters the VTS at Hinchinbrook Entrance. It transits the Sound in the east tanker lane, which provides separation from outbound, laden tankers.
- The inbound tanker is met by the Valdez harbor pilot at Bligh Reef light for transit of Valdez Narrows. Restrictions based on tanker size, wind speed, and sea state are in place. A holding area is specified at Knowles Head for tankers if weather closes the port or keeps outbound tankers from transiting Hinchinbrook Entrance.
- Berthed tankers are surrounded by an oil spill containment boom for the entire deballasting and loading process. Ballast water is pumped to the BWTF at the Valdez Marine Terminal, where it is treated before being discharged into Port Valdez. Oil recovered as a result of the treatment process is returned to product storage tanks at the Valdez Marine Terminal.
- A predeparture conference is held, and drug and alcohol testing of the tanker's captain and crew are conducted as required. A harbor pilot boards the tanker. Two escorts accompany the departing tanker; one is tethered through the Narrows to Bligh Reef light.
- The SERVS base in Valdez provides escort vessels, response equipment, a response command center, and trained personnel.
- Prevention and response vessels maintain radio contact with inbound and outbound tankers and with the SERVS base. They also watch for icebergs from the Columbia Glacier.
- Each outbound tanker following the west tanker lane is accompanied by one or

two escort vessels (with a sentinel vessel in the area) and is monitored by the VTS.

- APSC has seven vessels equipped for spill response and assisting tankers. Two barges with response equipment are stationed in the Sound, and two are stationed at Valdez.
- Two enhanced tractor tugs built for the Sound are used for tanker escort, ship handling, fire fighting, and emergency response.
- An ocean-going tug on station at Hinchinbrook monitors outbound tankers until they are 17 mi beyond the entrance. It can provide assistance to tankers if needed.
- Response Centers with prestaged spill equipment are located at five locations throughout the Sound.
- APSC maintains contracts with more than 300 fishing vessels to provide assistance in the event of a spill. Its Valdez Star, the largest oil skimmer ever built in North America, was specifically designed for Prince William Sound. Also, three new tugboats were specifically designed and built for use by SERVS within the last three years.

Part 1 of the *Prince William Sound Oil Discharge Prevention and Contingency Plan* contains a Response Action Plan. This plan, as do other response plans, divides the response into an initial action and, if necessary, a broader, subsequent response, with checklists for the initial responders and for leaders in the broader response. Should an oil spill occur, either the SERVS Response Coordinator at the Valdez Marine Terminal or a Response Specialist onboard an ERV would automatically become the initial on-scene Incident Commander, who would provide the SERVS Duty Officer with sufficient information to brief the Initial Incident Commander. The Initial Incident Commander would make an immediate decision on the size and complexity of the incident and the need for additional resources. The initial response would continue until the source of the spill is determined, the flow of oil is stopped, and the personnel and equipment that have been mobilized are deemed sufficient to respond. The *Prince William Sound Oil Discharge Prevention and Contingency Plan* contains 19 initial response checklists.

If a spill requires additional response activities beyond the initial actions, the Initial Incident Commander would be replaced by the Incident Commander, and appropriate response strategies would be implemented. One response tactic is to use dispersants. The plan contains a checklist whose criteria should be satisfied before dispersants are applied. The considerations on the checklist include whether application of the dispersant would adversely affect the safety and operation of other vessels or shoreline protection and cleanup operations; whether chemical dispersants, spray units, and aircraft or vessels on which to mount the sprayers are available; and whether appropriate personnel are available.

Another response tactic is in-situ burning. The *Prince William Sound Oil Discharge Prevention and Contingency Plan* contains a checklist whose criteria must be satisfied before burning can begin. This checklist includes requirements to determine whether (1) the burn would impair safety and other operations, (2) appropriate equipment is available, (3) personnel capable of operating equipment safely and effectively are available, (4) personal protective equipment is provided, (5) heli-torches and their ignition systems are available, and (6) fire safety requirements are met. The suitability of in-situ burning depends on visibility, wind speed, the height and choppiness of the waves, the currents, and the thickness and water content of the oil slick.

4.1.4.4 North Slope

North Slope operators maintain oil spill contingency plans in accordance with state and federal laws. North Slope spill response plans are based on the operators' membership in ACS, an oil spill response cooperative. The *Alaska Clean Seas Technical Manual* (ACS 1999a) provides ACS member companies with a unified response plan for spills in the North Slope oil fields, both onshore and offshore, and spills from PS 1 to PS 4 of the TAPS.

Volume 1, *Tactics Descriptions*, contains a list of response tactics arranged by subject matter (Safety, Containment, Recovery and Storage, Tracking and Surveillance, Burning, Shoreline Cleanup, Wildlife and Sensitive Areas, Disposal, Logistics and Equipment, and Administration). Each tactic consists of the following elements: a simplified diagram, a brief narrative description, an equipment and personnel table, a support equipment table, capacities for planning, and deployment considerations and limitations. These data give sufficient information to quickly determine how a tactic should be and which equipment and personnel should be used to implement the tactics.

Volume 2, *Map Atlas*, contains 11- by 17-in. maps and legend pages that cover the developed areas of the North Slope and provide operationally useful information. The maps give detailed geographical, biological, and civil information on the region. Each color map contains information on facilities, roads and pipelines, culvert locations, prestaged response equipment locations, priority protection sites, topography, hydrography (including drainage divides and flow directions), and shoreline types.

Volume 3, *Incident Management System*, describes the incident command system and unified organization used by ACS member companies for responding to spills and other incidents and crises on the North Slope.

4.1.5 Social, Cultural, and Economic Mitigation Features

Many of the mitigative measures discussed in the above sections have social or economic mitigation consequences as well. For example, measures designed to reduce the likelihood or consequences of oil spills also reduce the likelihood and/or severity of impacts on subsistence harvests. Adverse effects on subsistence resources have significant sociocultural implications because of the economic importance of subsistence to rural Alaskans and because of the sociocultural importance of subsistence to Alaska Natives. Therefore, measures that reduce subsistence impacts also lessen social impacts. As a second example, the pipeline has been designed with features to mitigate or preempt possible impacts on the free passage of terrestrial mammals. These measures also limit adverse impacts on subsistence harvests.

Both the Federal Grant and State Lease contain numerous provisions that identify mitigating measures and duties to abate/ rehabilitate damages relevant to possible social impacts. For example, several sections of the Federal Grant require measures that limit, mitigate, or require rehabilitation of potentially adverse TAPS impacts. These include:

- Section 9: Construction Plans and Quality Assurance Program,
- Section 10: Compliance with Notices to Proceed,
- Section 13: Damage to United States Property; Repair, Replacement or Claim for Damages (including requirements to rehabilitate any natural resource that shall be seriously damaged or destroyed),
- Section 16: Laws and Regulations,
- Section 23: Port Valdez Terminal Facility (including provisions to minimize environmental impacts),
- Section 24: Duty of Permittees to Abate,
- Section 29: Training of Alaska Natives, and
- Section 30: Native and Other Subsistence.

As another example, most stipulations associated with the Federal Grant are designed to prevent, mitigate, or rehabilitate potential impacts. Three categories of stipulations are included in the Federal Grant: general, environmental, and technical. For example, in the general category, Stipulation 1.9 (Antiquities and Historical Sites) requires that an archaeologist provide surveillance and inspection of the TAPS and its archaeological values, including an assessment of the protection measures to be undertaken by the Permittees if archeological resources are discovered. In the environmental category, nearly all stipulations serve to mitigate social impacts. For example, Stipulation 2.10 (Aesthetics) instructs the Permittees to consider aesthetic values in planning, construction, and operation of the TAPS. This stipulation includes specific provisions (e.g., limitations on the straight length of pipeline segments visible from highways) to limit aesthetic impacts. Stipulation 2.5 (Fish and Wildlife Protection), in turn, identifies measures that protect wildlife. In the technical category, many stipulations also mitigate possible social impacts. For example, Stipulation 3.6 (Stream and Flood Plain Crossings and Erosion) contains provisions to minimize the effects of scour, channel migration, undercutting, ice forces, and degradation of permafrost.

Mitigation measures are also identified in specific commitments made by TAPS Owners and/or APSC. These measures appear in numerous documents, such as various oil spill contingency plans and consent agreements. For example, Section 29 of the Federal Grant requires permittees to enter into an agreement for recruitment, testing, training, placement, employment, and job counseling of Alaska Natives. The purposes of this section are to ensure that Alaska Natives receive certain economic benefits from TAPS operations and to help alleviate the chronic unemployment found on the North Slope and in many Alaska Native communities throughout the state. A Native Utilization Agreement was put in place in 1995 to define employment goals (expressed as the percentage of positions to be filled by Alaska Natives) by labor category by year.

From time to time, companies institute or modify internal policies that mitigate possible social impacts. For example, access to oil field lands is one of the subsistence issues on the North Slope. Traditionally, all access to the oil fields for subsistence hunting has been restricted for security and safety reasons. Phillips Petroleum has agreed to permit access for subsistence hunting and fishing purposes to its Alpine and Tarn developments, with certain security/safety-related exceptions. This access serves as a mitigation measure for subsistence-related cumulative impacts.

Concerns for the potential adverse consequences of increased interaction between oil industry workers and local residents of North Slope villages are often addressed in EIS analyses of North Slope developments (e.g., BLM 1998). Specific impacts noted include the growth of racial tension between oil workers and residents, introduction of new values and ideas, and increased availability of drugs and alcohol (BLM 1998). Analysts (e.g., BLM 1998) claim that these effects could cause “some disruption to sociocultural systems” but concede that these impacts “would not displace existing institutions.”

The alignment of economic and other factors — which provides an impetus for enclave development — also creates a de facto mitigation measure. Potential social benefits of enclave development are acknowledged implicitly in the National Petroleum Reserve-Alaska (NPR-A) EIS (BLM 1998).

4.2 Impacting Factors

In the environmental report (ER) for the TAPS ROW renewal (TAPS Owners 2001a), APSC identified and described a number of activities related to pipeline operation and maintenance (O&M) that are either ongoing or reasonably anticipated over any period of continued TAPS operation. These O&M activities are necessary not only to preserve the integrity of TAPS, but also to comply with conditions contained in the Federal Grant of ROW and Stipulations (TAPS Owners 2001a). This section provides a qualitative discussion of the impacts associated with those routine or reasonably anticipated activities.

Also in the ER, APSC provided a brief description of the activities that would constitute termination of the TAPS operations (TAPS Owners 2001a). That description is based on more detailed engineering conceptual plans also developed by APSC (APSC 1983). The activities identified in Section 4.2.4 are derived from APSC's general descriptions of termination contained in the ER as well as the activities described in the APSC engineering study.

4.2.1 Factors Resulting from the Existence of TAPS Facilities

Notwithstanding the mitigating design features of the TAPS discussed in Section 4.1, the mere existence of TAPS facilities has a continuous impact on the environment and extant ecosystems. These impacts exist irrespective of TAPS operations. Both ROW facilities and off-ROW facilities have been and will continue to be sources of potential impact. Impacts from pump stations, river crossings, mainline refrigeration units, material sites, the workpad, and access roads, as well as the pipeline itself, have included alteration of localized surface water drainage and flood patterns and potential alteration of the behavior of subsurface waters, including groundwater in near-surface aquifers and suprapermafrost water. Support structures for river crossings have resulted in the alteration of river channels, changes to erosion patterns, and some bank scouring. In many instances, the slopes of river embankments have been highly modified in the vicinity of the TAPS crossing to ensure stability of TAPS structural support systems. Stream migrations, if they were to occur, may also impact the habitats of anadromous fish. Changes to thaw lakes, lakes, and wetlands may also result from the presence of TAPS facilities. Surface water drainage into Prince William Sound from the Valdez Marine Terminal, facilitated by substantial areas of paved or graveled land surfaces, also has a potential impact to the near-shore marine environment within the Sound. Workpads and land areas (either gravel or paved areas) at pump stations have potential continuous impacts on permafrost because of potential changes to the rates of absorption of solar insolation and water infiltration.

Other impacting factors include the potential alteration of animal habitats and migration patterns. Altered habitats and migration patterns also have continuing impacts on subsistence and on commercial and sport hunting and fishing. The workpad and access roads have also impacted mobility, and thus the range, of sport and subsistence hunters and animals. Off-ROW facilities, such as material sites and landfills and their associated access road systems, also may have similar impacts to the natural environment and ecosystems, regardless of whether active mining is occurring or waste is being disposed. These impacts are localized and include such factors as visible scarring, increased fugitive dust, altered surface water drainage patterns, altered rates of absorption of solar insulation due to removal of vegetative cover, and increased potential for siltation of nearby watercourses. Potential impacts to thermokarst can also be associated with the existence of material sites. Although no impacts on weather were identified from the mere existence of TAPS facilities, the workpad, access roads, and graveled areas around pump stations, as well as areas from which vegetative cover has been removed, have the potential to produce localized impacts to air quality by affecting fugitive dust generation. Impacting factors derived from facility existence have been incorporated into the analyses of impacts presented in Section 4.3.

4.2.2 Factors Associated with Routine TAPS Operations

Section 4.2.1 provides a discussion of impacts that result from the existence of TAPS facilities. In general, those impacts can be expected to continue throughout the period of continued operation defined by the proposed action. Additional impacting factors are associated exclusively with the operation and maintenance of the TAPS. These impacts result from routine operations, routine and preventive maintenance activities, repairs, and planned or potential TAPS upgrades, including rerouting pipeline. Those discrete O&M activities thought to have the greatest potential for impact are described below. Only actions that are known to be ongoing or that are reasonably foreseeable are addressed. Basic descriptions of the actions are provided and serve as the basis for the more detailed impact analyses in Section 4.3. Impacts discussed in Section 4.1 where mitigation has occurred through design features or operational controls are not discussed again here.

The potential impacting factors associated with each type of routine pipeline maintenance and repair activity are described in the sections below. However, some general observations can be made with respect to the potential impacts of those routine activities. Impacting factors fall into one of two broad categories: those associated with support of the workforce and those derived from the particular activity being performed. Impacting factors associated with workforce support routinely include the operation of vehicles and equipment, which results in air emissions and noise. Sustaining the workforce also can impact water resources because withdrawals are made for potable domestic and industrial use. These activities result in the generation of sanitary and/or domestic wastewaters, as well as industrial wastewaters. Domestic solid wastes can also be expected. In most instances, these impacts will occur at the nearest housing locations for the workforces involved rather than at the individual worksites. For major repair actions, however, temporary workforce quarters may need to be established at the work site.

The individual maintenance or repair activity can also have potential impact to local resources. Invariably, hydrostatic testing of repaired or replaced equipment will be required, resulting in impacts to water resources both from withdrawals of water used for such testing and from release of the test waters. Many of the routine activities also will result in ground surface disturbance (e.g., brush clearing, excavations, access road construction or modification, mining of gravel and rock at material sites, temporary staging of materials and equipment). Such ground surface disturbances can subsequently impact surface and groundwater resources, vegetation (including primary animal subsistence food resources), air quality (as a result of increased potential for fugitive dust generation), and cultural resources located at or close to the work sites (or the off-ROW material sites that are used to support the activity). The potential for these impacts exists regardless of whether the footprint of the activity is confined to the ROW or the areas adjacent to the ROW.

4.2.2.1 Routine Pump Station Operation

Section 3.1.2 provides an overview of the operational pump stations and their major features. Many impacting factors result from normal operations. Impacts to air quality result from the consumption of fossil fuels and the subsequent discharge of products of combustion. The pump turbines, electric power generators, comfort heating units, flare stacks, and solid waste incinerators are the major sources. Air quality is also affected by the release of VOCs from overpressure vents (“pop valves”) on various process equipment, balance tanks at PS 1, and breakout tanks at other pump stations. Impacts to air quality can also result from nonroutine events such as fires, including the release of fire suppressing agents in response to such events. Finally, during extremely cold weather, the operation of internal combustion sources results in the formation of ice fog near the ground surface, which creates short periods of reduced visibility. The formation of ice fog also may indicate a buildup of other combustion products at near-surface elevations of the atmosphere. Water resources are impacted from the withdrawals of ground and surface waters for both domestic and industrial uses. Water resources are also impacted from the treatment and discharge of domestic wastewaters, including releases from septic systems used at some pump stations. Surface waters are also impacted from the discharge of storm waters from industrial areas, including secondary containment features at storage tanks. A wide range of additional activities result collectively in impacts from vehicular traffic, noise, and fugitive dust. Routine vegetative clearing (in accordance with the JPO Brushing Plan [Brossia and Britt 2001]) to maintain the work area also results in impacts to the terrestrial environment and potential impacts to nearby surface waters. Finally, operations at the pump stations result in impacts at remote locations. These include impacts to the terrestrial environment, surface waters, and groundwaters from the land disposal of pump station solid wastes.

4.2.2.2 Routine Valdez Marine Terminal Operation

Impacting factors from operations at the Valdez Marine Terminal are similar to those resulting from pump station operations. Consumption of large volumes of fossil fuels in various internal and external combustion sources results in the release of combustion products into the atmosphere. A flare stack, an “oily waste” incinerator, and an air stripper associated with the BWTF also contribute air pollutant emissions. Water resources are affected by the withdrawal of water from wells and surface streams for industrial uses. Water resources are also impacted by discharges to Port Valdez of treated sanitary wastewater and treated industrial wastewaters from the sewage treatment plant and the BWTF, respectively. Storm water runoff from the Valdez Marine Terminal also impacts waters of Port Valdez. However, storm water from industrial areas of the Valdez Marine Terminal is captured and sent to the BWTF before discharge. Finally, Port Valdez is also impacted from tanker traffic to and from the Valdez Marine Terminal, together with escort vessel traffic. Valdez Marine Terminal operations also impact the environment as a result of solid waste generation and subsequent disposal in off-site landfills. Industrial solid waste generation at the Valdez Marine Terminal results in land impacts from disposal in area landfills. Although industrial hazardous wastes are treated and disposed of in out-of-state facilities, the transport of those wastes results in local impacts.

Operation of both the BWTF and the sanitary wastewater treatment plant results in impacts from the generation and subsequent management of sludge. Aeration of BWTF sludge results in nominal impacts to air quality. Sludge from the BWTF and the sanitary plant is delivered to the City of Valdez wastewater treatment plant for further treatment.

The routine transfer and storage of crude oil and refined petroleum products result in impacts to air quality through the release of VOCs. Loading of crude oil into tankers also results in the release of VOCs. However, impacts to air quality from these activities are mitigated by the capture and combustion of volatile organic releases. Finally, many operations at the Valdez Marine Terminal collectively contribute to increased traffic volumes and noise impacts.

4.2.2.3 Routine Operations of the Pipeline

Notwithstanding spills or accidental releases, routine operations of the pipeline result in nominal impacts. Various internal combustion power generators impact air quality from the release of combustion products and also are a source of noise. At some remote gate valve (RGV) locations, propane-fired generators are continuously operational and would also have nominal impacts to air quality and noise.

Three sections of the TAPS, approximately 4 mi in total length near Gulkana, are buried in thaw-unstable permafrost. These sites are mechanically refrigerated to prevent thawing of the soil surrounding the warm pipeline and possible settlement of the pipeline. Mechanical refrigeration systems may require replacement or upgrade for improved performance and durability during the ROW renewal period (TAPS

Owners 2001a). Replacement or servicing will result in impacts typically associated with excavation, including impacts to water resources from excavation dewatering or vegetation clearing. Impacts may also result from the removal and disposition of the brine solution that acts as the heat transfer fluid in these refrigeration units. Noise and increased vehicle and construction equipment traffic can also be anticipated during removal or replacement activities. Typical routine servicing of the refrigeration units will have limited short-term and localized impacts, including vehicle traffic, noise, and possibly the generation of industrial wastes.

4.2.2.4 Routine and Preventive Maintenance Actions

4.2.2.4.1 Slope and Workpad Maintenance. Workpad repair activities normally include maintenance of safety of slopes and elevations, regrading, revegetation of adjacent areas, clearing of obstructed surface drainage pathways, adjustment of aboveground pipeline elevations, and the installation of passive thermal-transfer devices (heat pipes) to maintain slope stability when necessary. Impacting factors associated with these activities include increased vehicular traffic, increased noise levels during repair activities, and mining and transport of gravel or soils to the work site. In those instances where deterioration of slopes has progressed to significant levels, replacement of vertical support members may also be necessary. In such cases, additional heavy equipment would also be involved and excavation would be necessary. Although heat pipes contain a hazardous chemical (anhydrous ammonia), they are sealed, and impacts from their installation and subsequent operation will not be influenced by the presence of the ammonia. Slope and workpad repair actions are confined to the workpad and adjoining areas.

Finally, vehicular traffic on the workpad access roads can itself be an impacting factor, irrespective of the purpose for which the vehicle is being driven to the workpad. Many access roads cross small, low-volume and intermittent streams. Low-water crossings have been designed to prevent alteration of stream cross sections and subsequent impacts to water flow and fish habitats. Surveillance by both APSC personnel and state authorities extends to identifying maintenance needs for those crossings. Conducting work on the ROW during the winter months can also reduce such inadvertent impacts from vehicles. Vehicular traffic both on TAPS access roads and the Dalton Highway may also impact animal migration patterns.

4.2.2.4.2 Valve Vaulting, Maintenance, and Repair. Main-line valves undergo extensive performance testing. When such testing indicates that applicable performance standards are not being met, valve inspection, maintenance, refurbishment or replacement is scheduled. Because adequate valve performance is essential to fundamental control of oil flow through the pipeline and the ability to successfully isolate pipeline segments to facilitate repairs as well as responses to accidental releases, valve maintenance receives high priority. The rate of valve inspection for corrosion, possible sealing problems, and other damage is currently about five valves per year (TAPS Owners 2001a). Since initial construction, four mainline valves have been replaced or repaired because of sealing-performance deficiencies — two aboveground gate valves and two belowground check valves (TAPS Owners 2001a). One RGV is scheduled for replacement in the 2002–2003 time frame (Norton 2002a). Although there are insufficient data regarding valve failure to predict the levels of future valve replacement activities, it is anticipated that general maintenance levels for all valves will increase in the future (Jackson and White 2000). Three RGVs removed from service as part of the Atigun Pass reroute completed in 1990 have been inspected for wear. These inspections have provided useful data for RGV maintenance and intervention schedules and criteria (Norton 2002a).

In response to a JPO directive, APSC is currently installing vaults around buried main-line check valves. This installation program is expected to be completed by 2003. Once installed, the vaults will facilitate routine inspections and performance testing of valves and will reduce impacts of such activities, particularly when excavation is required (see Section 4.2.2.6.2 for additional discussion). However, the impacts of installing the vaults and replacing vaulted valves, when necessary, would be the same as current activities to replace buried valves.

Replacements of buried valves will involve excavating anywhere from 18 to 48 in. of compacted gravel (that portion of the workpad immediately above the valve) and soil overburden and pipeline backfill materials, extending to depths ranging from 4 to 20 ft below grade. Excavations are likely to extend a few tens of feet to either side of the valve location to provide an opportunity to inspect adjoining pipeline segments for corrosion and to facilitate reattachment of the repaired or replacement valve. A typical excavation can be expected to result in land disturbance of a surface area approximately 50 by 200 ft. All replacement valves undergo hydrostatic testing before installation. Valve replacements in buried sections of pipeline may also require dewatering of the excavation and the importing of additional backfill sands or gravels to reestablish the original grade and workpad once repairs or replacements have been completed. All work is expected to occur within the dimensions of the previously disturbed areas. However, excavated materials and support equipment may be temporarily staged on adjacent areas. Some vegetative clearing and repairs or modifications to access roads may also be necessary to support the work effort. Support equipment will include portable electric power generators and temporary fuel storage for excavation and lifting equipment. Valves are precoated with an epoxy or phenolic coating. After installation, there will be minor amounts of field dressing of the valve body and adjacent mainline pipe segments with phenolic corrosion control coatings.

Impacts associated with replacing buried valves include ground disturbance from excavation and temporary stockpiling of excavated fill; impacts to surface water from the discharge of excavation waters or from increased siltation potential because of ground disturbances; the generation of small amounts of waste from surface preparation and recoating of the adjoining pipeline segments; local and short-term impacts to air quality from the consumption of fossil fuels by vehicles and construction equipment, as well as the creation of fugitive dust; impacts to air quality from increased fugitive dust; impacts to the terrestrial environment not only from the excavation but also from the possible need to clear vegetation around the work site for vehicle and equipment access; and impacts from increased vehicle traffic, including the release of air pollutants, fugitive dust, and noise. Impacts may also result at off-site material sites for mining and hauling of additional fresh materials for bedding and padding the new valve and adjacent pipe. New materials may also be needed to repair or modify the access road to support heavy construction equipment. In most instances, it is not necessary to import additional overburden fill soils to reestablish the original grade at the completion of the project. In fact, on some occasions, excess fill materials may need to be removed from the work site because of the use of fresh bedding materials.

4.2.2.4.3 Surveillance and Monitoring Activities. Detailed descriptions of mitigative surveillance and monitoring activities are provided in Section 4.1. Monitoring and surveillance are conducted for the following: slope movement and deterioration, VSM movement, pipeline movement, glacier movement, earthquakes, internal and external corrosion in the pipe, and vandalism. Surveillance also extends to routine measurements of currents and resistivity in the "impressed current" cathodic protection systems installed on some portions of buried pipeline as well as monitoring of conditions in sacrificial anode protection systems. Surveillance uses conventional vehicles on established workpads and access roads. Helicopters provide year-round aerial surveillance. Light aircraft are used for aerial photography to measure glacier movement. Surveillance during winter months is conducted using four-wheel drive trucks, Tucker Snow Cats™, or snow machines. Impacts from routine surveillance activities are nominal and relate primarily to site access by inspectors, including increased vehicular traffic (including air reconnaissance) and noise. The surveillance and monitoring activities themselves have no notable impacts.

Surveillance for pipeline movement and corrosion is also performed remotely through the use of instrument pigs (also sometimes referred to as "smart pigs"). Pigs are "launched" into the main pipeline at PS 1 and 4 and carried along in the flow of oil. Pigs can be recovered at PS 4 or at the Valdez Marine Terminal. Earthquakes are monitored through an array of accelerometers located at pump stations and the Valdez Marine Terminal. The use of smart pigs and accelerometers does not impact the ROW per se; however, interpretation of the monitoring data may lead to additional excavations to facilitate visual inspections of suspect or potentially affected portions of the pipeline.

4.2.2.5 Repair Activities

4.2.2.5.1 Corrosion Digs. External corrosion investigations ("digs") of buried mainline pipe occur on the basis of the review of data gathered by smart pigs and annual close potential corrosion surveys. Historical corrosion data analyzed through the corrosion data management system database may also dictate corrosion digs (Norton 2002b). Mainline pipe sections where pipe-wall thinning is detected are excavated and examined. Pipe coatings and cathodic protection systems are repaired to stop additional wall thinning from corrosion. In some cases, full-encirclement pipe sleeves are installed to reinforce the pipe where anticipated hydraulic pressures require additional measures of safety.

Uncovering main-line buried pipe for examination and repair usually results in an engineered excavation of about 60 linear feet of pipe (Tart and Hughes 1998). The excavations usually disturb a surface area of about 50 by 200 ft within the previously disturbed area. Many digs occur in a sequence, so a number of such excavations may occur in a given winter construction season. Impacts from this series or "cluster" of corrosion digs will be proportionally greater than those for an individual corrosion dig. Depth of soil cover over the top of the pipe varies from 4 to 20 ft, with side slopes generally at a ratio of 2 to 1. For personnel safety, the slopes of the excavation are no steeper than 1.5 to 1. Excavations occurring in wet areas are more complex and are carried out in winter to reduce the need for dewatering; however, dewatering may be required at any time of the year. Water pumped from excavations is discharged in accordance with APSC's linewide NPDES permit. If required, excavation of pipe segments buried beneath rivers would have more far-ranging impacts and would likely also require extensive river training (redirection) over the period of the work. Conducting such actions in the winter months when flows are substantially reduced or even stopped can mitigate impacts to the river.

Impacts from these repair activities are localized and of short duration and include increased vehicular traffic, equipment noise, discharges of excavation waters to the land surface or nearby streams, possibly some vegetative clearing within the work area, and the possible importation of small volumes of additional fill materials. The work effort also involves minimal amounts of sandblasting to remove the original coating and surface rust and application of a phenolic coating. Cathodic protection systems (impressed current or sacrificial anodes) may also be upgraded or installed to prevent corrosion or reduce the rate of corrosion. An estimated 15 digs will occur each year, potentially increasing to 20 by the end of 2034 (Norton 2002b). Figure 4.2-1 shows the numbers of APSC corrosion investigation digs since 1989.

4.2.2.5.2 Maintenance, Repair, or Replacement of Main-Line Cathodic Protection Systems. Cathodic protection of the main-line pipe and various other TAPS facilities against corrosion is directed by the Corrosion Control Management Plan agreed to by the JPO and APSC (APSC 1999b). Cathodic protection systems are described in Section 4.1.2.3. Monitoring and surveillance actions are described in Section 4.1.3.2.1. Remedial action is taken if cathodic protection is determined to be inadequate or the installed system is not meeting its performance requirements. Impacts from the surveillance of already installed cathodic protection systems are minimal and localized and include primarily noise and increased vehicular traffic associated with the physical surveillance of the system. However, testing, monitoring with instrument

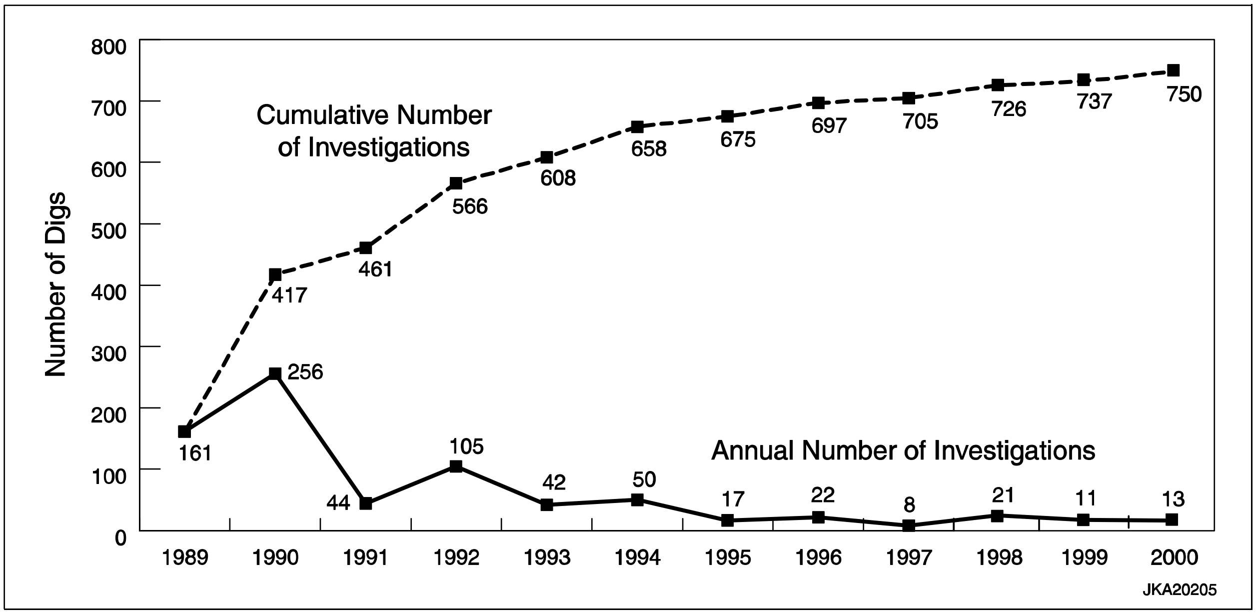


FIGURE 4.2-1 TAPS Corrosion Investigation Projects for Underground Main-Line Pipe (Source: TAPS Owners 2001a, Figure 4.1-1)

pigs, and corrosion histories of certain pipeline segments may indicate that existing ground beds need to be repaired, replaced, or improved, or that additional ground beds for impressed current cathodic protection systems need to be installed. As many as six to eight repairs or replacements of impressed current ground beds are expected from 2004 to 2034 (TAPS Owners 2001a).

Repairs, replacements, or new ground bed installations will have impacts similar to those encountered during initial installation. Those impacts include increased vehicular traffic, noise, vegetation clearing, and excavations. Equipment used will include excavation equipment, portable power generators, and possibly temporary storage facilities for vehicle and equipment fuels. Because installation or repair is expected to occur over relatively short time frames and because water accumulated in the excavation is not expected to seriously impede installation, minimal excavation dewatering is likely to occur. Horizontal ground beds at pump stations are likely to have been installed entirely beneath the graveled footprint. Repair or replacement of horizontal beds would therefore have only minimal impacts to the ground surface. While most repair actions are expected to occur within the existing ROW, replacement of remote vertical ground beds may also involve construction of temporary access roads and thus result in substantially greater areal extent of ground surface disturbance. Power rectifiers will also need periodic replacement. From 2004 to 2034, the addition of 20 to 30 new impressed-current rectifiers can be expected (TAPS Owners 2001a). Impacting factors associated with rectifier replacements include increased vehicular traffic and noise but not excavation. Removed rectifiers will be solid wastes and are likely to be sold as scrap.

Maintenance of sacrificial anode-type cathodic protection systems requires periodic excavation and removal of the remains of the original magnesium anode and placement of a new anode. Anode depths can generally be expected to be at or near the lowest elevation of the pipeline at that location. Impacting factors associated with sacrificial anode replacement will be similar to those encountered for the ground bed repairs or replacements discussed above.

As the pipeline ages, the coating degrades, more bare metal is exposed, and greater demands are placed on the cathodic protection system. The existing system may ultimately be unable to supply sufficient corrosion protection.

At that point, either additional protection must be added or the coating must be refurbished. In those instances, excavation of the affected pipe segment will be required, and impacting factors similar to those discussed above for corrosion digs will result. It is estimated that rehabilitation of less than 5 mi of pipeline will occur during a 30-year renewal period (TAPS Owners 2001a).

4.2.2.5.3 River Crossing and River Training Structure Repairs. River training structures are required when changes to the natural course of rivers represent a threat of erosion of pipeline structures and thus a loss of pipeline integrity. Because river channels are subject to seasonal change, all locations requiring river training structures could not be identified during initial design and construction. While some locations requiring river training could be identified in the design phase, other locations could only be identified by monitoring changing river conditions over time or after major flood events. It was anticipated that maintenance of existing river training structures would be necessary and that new structures might be needed in response to major floods or stream migration. Historically, some repair to existing structures, as well as construction of new structures, has occurred almost every year. A typical repair may involve adding riprap to a washed-out spur nose or to a riverbank. All work is conducted in accordance with environmental permits. Emergency or temporary repair work is performed in accordance with methods practical at the time for the specific location, with oversight by regulatory agencies.

In addition to maintenance of river training structures to ensure pipeline integrity or to preempt problems from erosion, repairs or additions may also be made to facilitate ROW access. For example, a dike was constructed along McCallum Creek in 1999 to mitigate workpad overflows caused by icings. In the Atigun River floodplain, repairs to the workpad were necessary in the 1990s to maintain access to a check valve.

The scope of future maintenance needs depends primarily on the timing, location, and magnitude of high-flow events. The record, widely distributed floods on the Sagavanirktok River and Middle Fork Koyukuk River systems in 1992 and 1994, respectively, and the required response/maintenance plans, are probably representative of the scope of major maintenance initiatives that could be required in the future if record or near-record floods occur. Work will likely be required at a number of locations along the Middle Fork Koyukuk River in the future where pronounced, well-developed channel bends are moving toward the pipeline. (The migration of these bends is being closely monitored to be able to implement remedial measures in a timely and sound manner.) Future channel changes and possible additional works that might be required along the Sagavanirktok River are more difficult to estimate, as the multi-channeled braided nature of this river causes predictions to be largely speculative in nature. Dramatic and rare events such as the simultaneous release of the glacier-dammed lakes in the Tazlina River watershed are difficult to predict with accuracy. The north bank of the Tazlina River was armored in 1998 to 1999 as a protection measure for this type of event.

Impacts from maintenance or construction of river training structures are primarily noise, dust, gravel, and rock mining (either local or remote); increased siltation from disturbed land or newly placed gravel; and sediment generation from construction activities. Riparian habitats north of the Brooks Range can also be expected to be impacted by increased siltation in surface water drainage. It may also be necessary to place construction equipment directly in the watercourse. Thus, the potential exists for contamination of the watercourse by the various fluids present in the equipment. However, where possible, construction of the training structure is conducted in such a way to avoid contamination. Further, whenever possible, construction of training structures takes place in winter months when the flow in many rivers is reduced dramatically. However, low-flow conditions are themselves a high-risk period for fish that inhabit the river. Impacts on adjacent structures or on natural vegetation and flow patterns are also possible. Once completed, training structures can have local impacts, such as enhanced local bank erosions at the upstream end of the structure. In general, these structures are designed to minimize erosion impacts. However, overall erosion will still occur in certain areas. In some instances, river training structures can have more significant impacts on flow patterns in the downstream direction. Such impacts, however, may be significantly reduced in braided streams. Innovative techniques, such as the Rosgen technique, are being used along the TAPS to minimize the disturbance during construction and to minimize the types of impacts that are sometimes associated with larger structures used for river training. Although it is difficult to anticipate all the impacts resulting from river training activities, the historical record provides the following examples of potential impacts:

- Spurs such as the one at MP 47 can have a significant local impact on flow; however, even at this location, their impact is nominal compared with natural changes that can occur in the wide, braided Sagavanirktok River.
- The revetments along the Dietrich and Middle Fork Koyukuk Rivers since the major 1994 flood, and along the north bank of the Tazlina River bridge in response to the 1997 flood, were built along the post-flood bank alignments and thus had little impact on overall flow patterns.
- Along the Middle Fork Koyukuk River in the MP 243 area, the length of additional spurs, required because of channel changes induced by the 1994 flood, were significantly reduced compared with the original spurs to minimize their effect on vegetated islands.
- At small creeks, such as Vanish at MP 145, where high flows in 1999 resulted in significant VSM vertical movement or tilting, it was necessary to deflect the flow into its original location. By careful layout and construction of the transitions from the armored areas back to the original banks, the impact of the river training structures and pipeline structural members on creek behavior and flow patterns is very limited.

The impact of the river on structural support systems is also closely monitored. Erosion, channel scouring, and buildup of debris can destabilize some structural support members that are positioned in watercourses. Actions virtually identical to river training are then undertaken to reestablish the integrity of the pipeline system at those locations. Impacts from the repair of these structural members are similar to those encountered during construction of river training structures. The areal extent of the impacts, however, is likely to be smaller.

4.2.2.5.4 Fuel Gas Line Repairs. Annual maintenance of the soil cover over the fuel gas line is required because of seasonal temperature variations and water runoff. Sections of the line are subject to thermal uplifting (jacking) each year because of seasonal freezing in thaw ponds and wet areas. These sections are analyzed for stress and corrosion (by visual observation and by smart pigs) and evaluated using an integrity-based approach. Several hundred feet of the line are reburied each year to maintain the minimum cover requirements in DOT regulations (see 49 CFR 192) (TAPS Owners 2001a). Most of the fuel gas line was built from snowpads, and no permanent gravel workpad exists. However, the fuel gas line runs adjacent to either the oil pipeline workpad or the Dalton Highway, both of which provide access for surveillance or repairs. No notable impacts result from surveillance and monitoring activities, except nominal impacts associated with personnel access to any given location along the ROW. Impacts resulting from repairs are related to excavation and include ground disturbance (albeit at a much smaller scale than excavations that occur as part of TAPS maintenance or repairs), clearing of vegetation, localized impacts to surface water from ground surface disturbances, increased vehicular traffic, and noise. Air quality impacts result from the consumption of fossil fuels in vehicles and construction equipment and short-duration increases in fugitive dust resulting from ground disturbances. Air quality impacts may also result from importation of additional gravels or soils to reestablish original grades or to serve as pipe bedding material. After repairs are complete, the ROW is regraded and revegetated. Many of the above-noted impacts can be minimized by performing most gas line repair work in the winter.

Impressed current systems located at PS 1, 2, 3, and 4 provide cathodic protection for the fuel gas line. Continued adequacy of cathodic protection is determined by annually monitoring 74 test stations along the gas line. Maintenance and repair of the cathodic protection system is based on a risk assessment performed in accordance with DOT OPS requirements. Impacts are similar to those discussed in Section 4.2.2.5.2 for TAPS cathodic protection systems. However, the majority of the impacts may be realized at the pump stations rather than along the gas line ROW.

4.2.2.6 Planned and Potential Upgrades

4.2.2.6.1 Pipeline Replacement or Reroutes. Recurring corrosion problems or the continued potential for pipeline settlement are the primary reasons for segment replacement or reroute. Replacement of mainline pipe sections is rare since most pipe repair work can be accomplished by installing full-encirclement pipe sleeves over damaged sections. Replacements or reroutes are performed only when this method of repair is infeasible or when evidence suggests that settlement or corrosion will recur because of uncontrollable circumstantial factors. Ongoing refurbishment of pipeline coatings and cathodic protection systems reduces pipeline repairs or replacements. Four pipeline reroutes/ replacements have occurred since 1977: (1) 3,600 linear feet at MP 200 near the Dietrich River in 1985, (2) 234 linear feet at MP 166 at Atigun Pass in 1987, (3) 200 linear feet at PS 3 in 1990, and (4) 8.5 mi from MP 157 to MP 165 near the Atigun River in 1991.

Impacts from pipeline replacements are similar to impacts from corrosion digs but at a much greater scale. Pipeline replacements are major construction projects that approach original construction impacts in scale for a localized area. Costs range from $1 million to $10 million per mile. Because of pipeline integrity monitoring, major reroutes because of corrosion are not expected during a 30-year renewal period. If they were to occur, pipeline reroutes would invoke the controls and requirements of numerous grant stipulations in much the same manner as original construction. Any reroute would be preceded by extensive design and planning activities, all of which would be subject to JPO review and approval.

4.2.2.6.2 Valve Vaulting. APSC is currently engaged in a systemwide project to install vaults around all buried check valves in response to a JPO requirement. The vaults are intended to facilitate future inspection and maintenance of these valves and also provide secondary containment for releases that may occur from these valves. Valve vaulting involves excavation to expose the valve, deepening the pipeline trench immediately below the valve to allow for a pre-formed concrete slab to be placed beneath the valve to serve as the floor of the vault, and installing preformed concrete slabs or corrugated metal pipe to serve as the walls and cover for the vault. While the valve is exposed, it is inspected for signs of external corrosion, and the surface is repaired and recoated with epoxy as necessary. Some nominal length of pipeline on either side of the valve is also exposed during excavation and also undergoes inspection and repair as necessary. No interruption of oil flow is required to accomplish valve vaulting. APSC estimates that vaulting will proceed at a rate of 5 per year, and that the project will be completed by 2003 (Malvick 2002).

Impacts from valve vaulting activities would be similar to those encountered during corrosion digs. However, the scale of a vaulting operation with respect to manpower, equipment, and material needs is slightly larger than that of an individual corrosion dig, and impacts have the potential to be proportionally larger. Most of the work is expected to take place on the established workpad; however, adjacent areas within the ROW may also be used for temporary staging. Excavation dewatering and increased potential for siltation because of ground disturbances can have temporary localized impacts on surface water resources. Air quality impacts can be anticipated as a result of the operation of portable internal combustion units on generators or air compressors as well as from the operation of lifting and excavation equipment. Air quality is also locally impacted by sandblasting that may occur to remove surface corrosion. Spent sand used in this blasting operation as well as the corrosion and original epoxy coating that is removed are left in the excavation as bedding material pursuant to ADEC approval (see Appendix C, Section C.6.8). Because the installed vault will occupy some space in the original excavation, no additional fill materials are anticipated to be necessary to reestablish the original grade at the end of the project. However, it may be necessary to import additional gravel to modify the access road and workpad to accommodate the heavy equipment used in lifting and positioning the pre-formed concrete or corrugated metal pipe. As with other construction activities along the ROW, vaulting will have impacts as a result of increased vehicular traffic and noise. Finally, once completed, the valve vaulting project will preempt or greatly reduce impacts from future monitoring and surveillance of buried valves as well as enhance APSC's ability to conduct these activities.

4.2.2.6.3 Planned Pump Station Upgrades and Valdez Marine Terminal Modifications. The potential for the TAPS system upgrades was identified in the ER for the TAPS ROW renewal (TAPS Owners 2001a). At the time that report was released (February 2001), numerous system upgrades or modifications had already been completed or were ongoing (e.g., rampdown of some pump stations and crude oil topping plants, enhanced communication systems, improved earthquake alarm and intervention systems, improved mainline leak detection capability, and vaulting of buried main-line valves). It is readily anticipated that upgrading the TAPS will continue to be a dynamic process that occurs throughout the operational period. Also, additional upgrades or modifications would likely occur over the period of the proposed 30-year renewal of the Federal Grant, precipitated by such factors as reduced North Slope crude oil production (and thus reduced TAPS throughput), JPO directives, technological advancements, or opportunities to enhance the overall efficiency and effectiveness of TAPS operations.

APSC has announced a conceptual engineering study of potential facility upgrades involving modifications to all but 1 of the 11 TAPS pump stations and to the Valdez Marine Terminal (APSC 2002). The study primarily looked at altering the configurations of pump stations, including eliminating some stations, and increasing the levels of automation at which the remaining pump stations would continue to operate. Other modifications being considered included replacing existing turbine pump drivers with more fuel-efficient drivers, while also increasing overall efficiency of TAPS operations. Pump drivers can alternatively be replaced by electric motors when commercial power is available as a means of reducing overall fuel consumption (and thus operating costs). Finally, the study considers the removal of two of the four tanker berths at the Valdez Marine Terminal. No significant change is being considered for the pipeline itself.

It is important to note that the proposed system upgrade exists at this time only as a preliminary engineering conceptual design study. More extensive engineering and numerous logistical details still need to be developed and approved before the plan can be executed. Further, all aspects of the study must be reviewed and approved by appropriate JPO agencies before the Authorized Officer authorizes APSC to proceed. It is assumed that any authorization to proceed would be issued only after APSC had demonstrated to the JPO's satisfaction that the requirements of all applicable Federal Grant stipulations would be satisfied both during the modifications and thereafter. It is further assumed that the JPO would apply its broad management authority to impose additional special stipulations as it has done on 11 previous occasions to ensure that the full intent of the Federal Grant is met (see Section 4.1.1 for a discussion of the JPO's specific and broad authorities). It is also assumed that planned upgrades would not occur if the Federal Grant is not renewed.

Although preliminary, in its current stage of development, the study provides a sufficiently detailed reference point against which to develop at least a qualitative analysis of its attendant environmental impacts and to compare those impacts with the analogous impacts of the existing TAPS facilities being considered for modification. That qualitative impact analysis is provided below. Where warranted and possible, more extensive, quantitative analyses of environmental impacts are given (see Section 4.3). Because the conceptual study of upgrades is preliminary, many engineering decisions have yet to be made. In many instances, absence of these decisions precludes a quantitative analysis of the impacts of the change. For example, APSC has proposed substituting existing turbine pumps with more efficient pumps. It is easily anticipated that such a substitution will result in reduced air emissions and fuel consumption. However, until substitute pump and driver models are selected, quantitative comparative analyses against the impacts of existing pumps is not possible. In such instances, the end point of the upgrade action is not sufficiently defined at this stage to allow for more detailed analyses of both short- and long-term impacts.

Details of Proposed Changes. Infrastructure changes are being proposed for all pump stations except PS 5 and for the Valdez Marine Terminal. However, the extent of the modifications differs at each pump station. At some, only the crude oil main pumps and some minor equipment may be modified. At others, in addition to replacing crude oil pumps, additional infrastructure will be removed or modified, electrical service will be modified, and automated controls will be installed. Finally, at those pump stations currently in a ramped-down status, all of the pump station infrastructure may be removed and replaced with a simple pipe segment interconnecting the mainline pipe. RGVs may be installed in these new segments to preserve overall flow control and facilitate spill response. These stations would, therefore, cease to be pump stations. More specifically, infrastructure changes being considered by APSC include the following:

- Replacement of existing electric power systems and pumping systems at PS 1, 3, 4, 7, 9, and 12, including the installation of new fuel gas-fired turbine generators and electric driver pumps at PS 1, 3, and 4 and, because commercial electric power is potentially available, installation of new electric motor-driven pumps at PS 7, 9, and 12;

- Removal of most existing aboveground physical facilities at PS 3, 7, 9, and 12, converting these pump stations to fully automated operations;

- Removal of all pump-station-related infrastructures at currently ramped-down PS 2, 6, 8, and 10 and installation of interconnecting pipeline segments and RGVs; and,

- Removal of tanker Berths 1 and 3 at the Valdez Marine Terminal.

Table 4.2-1 displays the overall changes to power systems and equipment that would occur in this upgrade at PS 1, 3, 4, 7, 9, and 12.

The study anticipates that all of the above actions could begin within two to three years once a final workplan becomes available and that these actions would be completed over a period of several years (assuming all necessary approvals and permits could be secured without unanticipated delays). With appropriate planning and scheduling, APSC anticipates that physical modifications to the pump stations can be accomplished with minimal disruption to pipeline operations or oil flow. In essence, modifications to pump stations would result in stoppage of oil flow in approximately the same manner as maintenance shutdowns that already periodically occur.

The following additional assumptions are applied as bounding conditions for the identification and analysis of impacting factors from the proposed upgrades:

- Appropriately modified corrosion control systems and thermal control features will be installed and maintained at the modified pump stations to protect any remaining facilities or equipment.

- Ancillary capabilities at pump stations would be preserved (e.g., smart pig capture and launching facilities at PS 4 would remain fully functional and facilities for the storage of refined fuels for vehicles and aircraft would remain in place at some pump stations).

- A separate contractor (or contractors) would perform the necessary physical alterations; work could occur simultaneously at more than one location.

- Razing of existing structures (if called for) will involve removal of all buildings and foundations and other engineered systems (e.g., foundation refrigeration systems) to a

TABLE 4.2-1 Planned Pump Station Upgrades

Pump Station	Power Sources		Facility Infrastructure	
	Existing	Upgraded	To Remain	To Be Added
1	8 operating fuel gas-fired turbines 8 spare fuel gas-fired turbines	Electric motors with 1 new gas turbine One spare power generation set and electric motors	Most existing equipment and structures	Nothing
3[a]	5 operating gas turbines 2 spare gas turbines	Electric motors with 2 new gas turbines	Main piping manifold, gas building, relief system, and booster pump	New electrical and instrumentation module for control and power distribution
4	4 operating gas turbines 3 spare gas turbines	Electric motors with 2 new gas turbines	Most existing equipment and structures	New electrical and instrumentation module for control and power distribution
7[a]	2 operating liquid-fuel turbines 2 spare liquid-fuel turbines	Electric motors with 1 liquid-fuel turbine	Main piping manifold, relief system, and booster pump	New electrical and instrumentation module for control and power distribution
9[a]	2 operating liquid-fuel turbines 2 spare liquid-fuel turbines	Electric motors with 1 liquid-fuel turbine Tie-in to commercial power or a secondary generator for standby power	Main piping manifold, relief system, and booster pump	New electrical and instrumentation module for control and power distribution
12[a]	1 operating liquid-fuel turbine 4 spare liquid-fuel turbines	Electric motors driven by commercial power One standby generator powered by liquid-fuel internal combustion engine	Main piping manifold, relief system, and booster pump	New electrical and instrumentation module for control and power distribution

[a] PS 3, 7, 9, and 12 will be converted to fully automated operations.

nominal depth of 2 ft below ground elevation.

- All work at the pump stations will be accomplished within the existing footprint (i.e., the paved or gravel roads and work pads at the pump stations) or adjacent to previously disturbed areas. Further, no new real estate parcels would be involved in the completion of this upgrade. Except for those minor disruptions to the workpad associated with structure removal, the gravel work pad and all access roads will remain undisturbed.
- Building components (e.g., structural elements, concrete, cinder block, and sheet metal) and infrastructure systems (e.g., heating, ventilation, and air-conditioning [HVAC]; plumbing; and electrical equipment) will be salvaged to the greatest extent practical; materials that cannot be recycled will be managed in generally the same manner as wastes from routine operations.
- The accumulation of dismantled equipment or structures will be kept to the minimum time periods necessary to accomplish efficient transport to salvage or disposal facilities.
- Existing TAPS or commercial housing facilities will be used to the extent practical to support the construction workforce. The contractor would construct and maintain temporary housing facilities and workforce support systems (e.g., cafeterias) when adequate housing is not available within a reasonable distance from the worksite.
- Work to remove the berths at the Valdez Marine Terminal will involve the use of both land- and water-based construction equipment.
- Work to remove the berths at the Valdez Marine Terminal will involve removal of the oil transfer legs, the VOC control (only from Berth 3), ballast water transfer plumbing, the piers, and all above- and below-water structural elements but will not involve dredging of sediments.

Although the physical modifications called for in the plan are extensive at the local level (i.e., at some of the pump stations), all of the proposed modifications collectively would not constitute a “reconfiguration” of the pipeline. Therefore, the proposed upgrade is considered to be a reasonably anticipated action within the context of the proposed action and is not sufficiently distinguishable from the proposed action to rise to the level of a separate alternative.

General Discussion of Impacting Factors Associated with Planned Upgrades and Modifications. Anticipated environmental impacting factors related to the execution of pump station upgrades and Valdez Marine Terminal modifications can be identified for both the short term (i.e., the “construction” periods during which physical modifications are taking place)[1] and the long term (i.e., from routine operation of the modified facilities thereafter). However, long-term impacts from modifications to pump stations that had been previously ramped-down will represent only marginal changes to the impacts those pump stations are now contributing during routine operation, since many of the impacts associated with operating pump stations had already ceased at these locations at the time of ramp-down. Over the short term, impacts will be equivalent to, or less than, those encountered during initial facility construction.

The most extensive impacts anticipated are short-term impacts associated with the wholesale removal of existing equipment at pump stations that will be eliminated (PS 2, 6, 8, and 10) and the installation of pipeline segments and RGVs to interconnect the pipeline segments entering and leaving these former pump stations.[2] Similar impacts of generally smaller dimensions can be anticipated from the less extensive removal or reorientation of equipment contemplated at PS 3, 4, 7, 9, and 12. The least

1 Here, the term, “construction,” includes any or all of the following activities: dismantling of equipment and structures, reorientation of equipment, installation of new equipment, and installation of pipeline segments and RGVs, where necessary.

2 It is not clear at this time whether newly installed pipeline segments will be above or below ground.

impact from dismantling and reconstruction will occur at PS 1 at which very little equipment changes will occur. Pump Station 5 is not included in this upgrade plan and will remain physically unaltered from its current condition. Similarly, at the Valdez Marine Terminal, the greatest impacts will be short term, occurring during berth and pier dismantlement. Long-term impacts associated with the use (or presence) of those piers will be very small.[3]

Changes to Short-term Impacting Factors Associated with Physical Modifications. Air pollution impacts during this period include increases in the amounts of air pollutants released (1) from the combustion of fossil fuels in various commuting and construction vehicles, portable power generators and heaters, incinerators used for the disposal of nonhazardous construction wastes and domestic solid wastes, and support equipment, and (2) from the operation of comfort heating and cooking equipment operated to support the construction workforce. Increased amounts of fugitive dust will result from increased vehicular traffic as a result of such activities as mobilization/demobilization of construction crews and equipment, commuting of construction personnel (when housing cannot be established at the work site), minor disturbances to the gravel work surface during building/foundation removals,[4] the transport of new TAPS equipment to the work sites, and the transport of dismantled equipment and building components to salvage or waste disposal locations. Localized noise impacts could also be associated with all of the above activities.

The access roads leading to the pump stations and the Valdez Marine Terminal are likely to be suitable for the conveyance of heavy construction equipment, new TAPS equipment, and dismantled equipment and structures, and no major road alterations are anticipated.

Because the disruption to the gravel pad will be minimal, large amounts of fill or new gravel are not expected to be necessary, except at those locations where new pipeline segments will be installed below ground (i.e., where new gravel will be required as bedding material). In addition to installing new pipeline segments, minimal amounts of new gravel may be required to re-establish grade in those areas where foundations or subsurface structures (e.g., refrigeration systems) had been removed. It is assumed that any new gravel needed will be obtained from existing (and closest) material sites.

Potable water usage will increase due to consumption by construction personnel. Proportional increases in amounts of sanitary wastewater will also result. Potable water will also be required to clean equipment. Industrial wastewaters that result from this cleaning will likely need to be transported elsewhere for treatment and disposal. It is anticipated that all construction-related water demands can be satisfied by using existing wells or surface waters; however, modified water withdrawal permits may be required. Modifications to the line-wide NPDES permit under which hydrostatic test waters are now discharged may also be necessary because of the anticipated increased volumes of hydrostatic test waters generated during equipment reconfiguration.

Construction activities can be expected to impact local surface water because the amount of silt in storm water flowing over recently disturbed gravel is expected to increase. At those locations where new pipeline segments will be buried, excavation waters will be generated and discharged to surface waters. An amended linewide NPDES permit may be required. Hydrostatic test waters will be generated as equipment is installed or

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3 In recent years, Berth 3 has been used only rarely to load oil tankers. Berth 1 had been used to berth tankers delivering diesel fuel for use at the Valdez Marine Terminal. However, those deliveries are now made by truck, and Berth 1 is no longer used (Edwards 2002).

4 However, where it is determined that new pipeline segments will be installed below ground, disturbance to the gravel pad will be more significant.

reassembled. It is anticipated that this water would be discharged under the existing linewide NPDES permit.

Increases in solid waste volumes (including putrescible wastes from cafeteria activities) can also be anticipated as a result of increases in workforce personnel (expected to be substantially greater than the number of pump station operating personnel routinely present), especially if the workforce is housed at the work site. Solid industrial wastes from the dismantlement of structures and equipment that has no salvage value will also be generated.

Emptying and cleaning of pump station equipment destined for removal or reorientation will result in the generation of wastes. Sludge, tank bottoms, and condensates removed from equipment may exhibit the characteristics of hazardous waste and will need to be transported to permitted out-of-state treatment, storage, and disposal facilities. It is possible that dismantled equipment will also require cursory cleaning to be eligible for salvage. Lightweight petroleum distillates (e.g., kerosene) may be used for such cleaning. However, it is possible that such rinsates as well as spent lubricating oils from various internal combustion equipment operated to support construction activities can be reintroduced into the crude oil product stream, provided no contaminants (e.g., chlorinated solvents) are introduced that would preclude the receipt of these rinsates at crude oil refineries. Other wastes that result from building dismantlement may require special handling because of the presence of chemicals or materials of special concern (e.g., asbestos-containing materials, PCBs, and mercury). The presence of such materials within the TAPS infrastructure, however, is limited, and only minor amounts of special wastes are expected.

Wildlife and fish habitats may also be impacted from increases in such factors as human presence; air pollution and noise; traffic; and levels of silt present in storm waters, excavation waters, or hydrostatic test waters being discharged from the construction zone. Little to no removal of vegetative cover is expected to be necessary; however, increased levels of traffic-related fugitive dust may nevertheless impact vegetation adjacent to the workpad, access roads, or the Dalton Highway.

Worker health and safety impacts routinely associated with typical construction activities will also occur during facility modifications. Health and safety impacts outside the construction zones are not anticipated.

Cultural resources may also be impacted by the dismantling of equipment and strucutres should the TAPS be determined an eligible historic property.

With respect to modifications at the Valdez Marine Terminal, all of the impacting factors noted above that are intrinsically related to construction projects can also be expected to occur at the Valdez Marine Terminal. Normally encountered health and safety impacts can be anticipated. However, because the deconstruction activities occur on or near the water, additional unique worker health and safety impacts also will exist.

Changes to Long-term Impacting Factors Associated with Operation of Modified Facilities. The net results of the planned pump station upgrades are a simplification or, in some instances, a complete elimination of complex mechanical systems that comprise a typical pump station. As discussed below, while it can be clearly anticipated that the proposed upgrade project has the potential for substantial short-term, generally localized, impacts, the much simplified facilities that result can be expected to produce fewer and smaller impacts during subsequent routine operation than did their predecessors. Likely changes in operational impacts as a result of the proposed pump station modifications are provided below.

The berths proposed for removal at the Valdez Marine Terminal have been used only rarely or not at all in recent years, and the current and projected operational levels at the Valdez Marine Terminal (i.e., frequencies of tanker berthings or volumes of crude oil shipped per unit time) will not be influenced by the presence of these berths or encumbered by their absence (Edwards 2002). Consequently, no measurable changes to the operational impacts from the Valdez Marine Terminal can be attributable directly or solely to the berth removals being proposed, and no further discussion of operational impacts from the modified Valdez Marine Terminal is necessary.

Many operational impacts will change as a result of the modifications proposed for the pump stations, including air emissions, water and energy consumption, wastewater generation, solid and hazardous waste generation, and impacts to surrounding habitats. Currently, the pump stations have multiple air emission sources, including the main turbine-driven pumps, generators, transfer pumps, flare stacks, steam boilers, comfort heating boilers, and waste incinerators. The largest single sources of air pollution at any pump station, however, are the turbine-driven pumps. Although some of the incidental sources of air pollution will remain unchanged, air pollution impacts from upgraded pump stations will still be reduced because the replacement drivers at PS 1, 3, and 4 are more efficient.[5] At PS 7, 9, and 12, criteria air pollutant emissions from main turbine-driven pumps will be totally eliminated because drivers at these stations will be run by electric motors powered by commercial electricity. PS 2, 6, 8, and 10 will be completely eliminated, and only small electric generators will remain as air pollution sources directly related to the TAPS operations. Air impacting factors, such as the incineration of solid wastes that now occurs at some pump stations, would be eliminated or greatly limited if the resident workforce were reduced or eliminated. In addition to reductions in air impacts from the introduction of modified equipment, additional reductions in air impacts can be anticipated because of the reduced frequencies of deliveries of fuels, replacement equipment, and provisions that are likely to be necessary to support simplified facilities and/or reduced workforces. However, these reductions are partially offset by the fact that the individuals who perform periodic maintenance on automated pump stations will be traveling to, rather than residing at, those pump stations.

In addition to the water used for consumptive or sanitary purposes, pump station water is also used to clean equipment and perform hydrostatic testing activities. Water used for industrial purposes will be dramatically reduced at those pump stations where equipment is removed and will be eliminated entirely at PS 2, 6, 8, and 10. Potable water usage at pump stations is primarily related to the size of the workforce, especially when the workforce resides on site. Increased levels of automation introduced at PS 3, 7, 9, and 12 may result in the complete elimination of the operating workforce at those locations.[6] Reduced workforce levels can also be expected at PS 4 and 5.[7] Potable water usage at ramped-down PS 2, 6, 8, and 10 is already limited to that which is necessary to support certain maintenance activities. Once all pump-station–related equipment is removed, water usage will be reduced to zero.

Domestic solid waste generation is also primarily a function of workforce size and depends further on whether all or part of the workforce resides at the work site. Therefore, proportional reductions in solid waste volumes can be anticipated at those pump stations where the workforce is either reduced or eliminated. However, industrial solid waste is not related to workforce size, but rather the complexity and maintenance requirements of the equipment at each facility. Although automated and greatly simplified, modified pump stations will still use equipment that requires periodic maintenance, one inevitable consequence of which will be industrial solid and/or hazardous wastes. Such maintenance activities will also use potable water and generate hydrostatic test water. At pump stations that have been eliminated (PS 2, 6, 8, and 10), only a newly installed pipeline segment and gate valve and communication infrastructure will remain, the maintenance

5 Replacement drivers at PS 1, 3, and 4 will burn fuel gas like the original pumps. However, higher operating efficiencies will result in more power delivered and less pollutants emitted per Btu of energy consumed, thus resulting in both a fuel savings and a reduction in air pollution.

6 A small security force is expected to still be present at these fully automated pump stations, but security personnel will likely not reside at those pump stations.

7 The APSC upgrade proposal also involves automating PS 4 and 5 to an extent that operating personnel may not be required. However, spill response personnel may still reside at these locations.

requirements of which will be no different than those for any other pipeline segment or gate valve. If the pipeline segment and gate valve at these locations are buried, maintenance-related activities will also result in impacts from excavations similar to those already resulting from the maintenance of buried pipeline segments. (Sections 4.2.2.4.2 and 4.2.2.5.1 discuss the impacts related to maintenance and repair activities on valves and buried pipeline segments.)

All of the modified pump stations will continue to have nominal impacts on surrounding ecosystems by virtue of the continued existence of the gravel pads and access roads. These features will continue to impact surface water drainage and nearby fish habitats and may have an impact on permafrost due to increased rates of absorption of solar insolation. However, many of the impacting factors associated with pump station operations will be reduced or eliminated. Impacts to ground waters and surface waters from potable water withdrawals and on-site sanitary wastewater and storm water management activities will be greatly reduced as a result of both reduced maintenance requirements of remaining simplified mechanical systems and reduced or completely eliminated workforces. Reduced human presence, reduced air pollution (including fugitive dust) and reduced noise levels can also be expected at modified, simplified, or eliminated pump stations.[8]

Other Changes to Impacting Factors from Planned Upgrades and Modifications. As noted in the preceding sections, the planned upgrades may result in the reduction or elimination of the workforces at some pump stations. Together with the changes to environmental and ecosystem impacting factors discussed above, these workforce changes will also have social and economic consequences. In addition to the obvious economic consequences for those whose jobs are eliminated, the lesser amounts of turbine fuels that will be required will impact the economics of commercial fuel suppliers. Simultaneously, there may be an opposite economic impact to those industries supplying commercial electric power, the demand for which will rise at those pump stations where the replacement pumps will be driven by electric motors.

Finally, modifications to the pump stations and the concomitant reductions or eliminations of the workforces at some pump stations will require a fundamental restructuring of the TAPS spill contingency plan with respect to its basic response strategy and logistical issues such as deployment of personnel and equipment for response. At the present time, APSC's first response to spills at certain locations involves members of pump station workforces. Where those pump station workforces change as a result of pump station modifications, new strategies will be required. APSC has indicated its intent to explore development of a spill response strategy that involves the development of regional response centers. However, many of the necessary details of spill response plan changes have yet to be determined. JPO review and approval of any changes to the contingency plans must also be secured.

4.2.2.6.4 New Material Sites/Rock Quarries. Continued O&M of the TAPS will require sand, gravel, and quarry rock to support workpad and access road repairs, flood damage control, and river training projects. From 1995 to 1999, APSC's annual usage ranged from approximately 30,000 to 97,000 yd^3 (TAPS Owners 2001a). It is thus conservatively estimated that APSC would need approximately 100,000 yd^3 of these materials per year of operation covered by a 30-year Federal Grant renewal. Most of these materials would likely be

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8 It can be reliably anticipated that replacement turbine drivers will generate less air pollution per unit of power delivered because energy savings is one of the primary motivations of these modifications. It is less easily assumed that any replacement driver selected will have a noise signature dramatically different than the current drivers. However, turbine drivers powered by electric motors are likely to be quieter than current fuel-gas-fired or liquid-fuel-fired drivers.

obtained from the 69 material sites on public lands for which APSC currently has mining permits. Many of these sites have existing stockpiles (TAPS Owners 2001a).[9]

Additional mineral extraction will result in the development of previously undeveloped portions of some existing material sites. Development of new material sites or reopening of previously closed material sites may also be required when existing mineral resources have been depleted. Within the footprint of the newly developed areas and access roads, this activity will result in modifications to the topography, loss of existing vegetation, land scarring, alteration of natural drainage patterns, and impacts to surface waters because of increased siltation potentials. Impacts to air quality from fugitive dusting off the exposed gravel are also likely. Impacts to cultural resources may also occur if newly developed areas are not first evaluated for the presence of those resources. The extent of surface disturbance from future material-site development is unknown but is likely to be limited to a few acres at each of the existing material sites. The size of possible new material sites will likely be significantly less than the typical 20- to 40-acre sites opened during construction. The construction-era material sites were used to construct extensive sections of the workpad, access roads, pump station pads, and the Haul Road (now the Dalton Highway). This required approximately 41 million yd^3 of mineral materials for the workpad and access roads and an additional 40 million yd^3 for the Haul Road. Future earthwork materials will be primarily for maintenance and will be minimal by comparison, approximately 3 million yd^3 over a 30-year renewal period.

Soil erosion and siltation may occur temporarily during mining and before stabilization of the disturbed surfaces. The four material sites currently used as sources of riprap will likely require blasting of rock faces, leaving an enduring visible rock face over a small area. Additional impacting factors include increased vehicular traffic, noise, and fugitive dust. Traffic and noise are short-term impacting factors, extending over the period of active mining and removal of materials. Fugitive dust represents both a short- and a long-term impacting factor and will continue until vegetative cover is reestablished at the end of the life of the material site. However, most of these sites are in remote locations, and the impacts discussed above are expected to be localized.

4.2.2.7 Health and Safety Impacts Associated with the Proposed Action

Health and safety impacts are associated with every aspect of routine TAPS operations, including routine and nonroutine monitoring, surveillance, and repairs. The TAPS is a complex mechanical system, the operation of which results in many health and safety impacts. The activities or principal aspects of TAPS operation that create potential health and safety impacts include trip or fall hazards; work from ladders or elevated platforms; work in high noise areas; areas of high fire risk; equipment operating at elevated temperatures or pressures; electrical hazards (especially for “hot” work, i.e., work that must be performed on energized circuits or equipment); operation of construction or industrial equipment; overhead lifting and manipulation of heavy objects; welding and open flame operations; confined space entries; use of power tools; work over water; excavations; travel in aircraft and ground vehicles; avalanche hazards; and potential exposures to hazardous chemicals, including crude oil, refined petroleum products, corrosive agents, organic solvents, asbestos, and PCBs (in electrical equipment). (See Appendix C for further details on the presence and distribution of hazardous or toxic substances in the TAPS.) Impacts from weather extremes, as well as encounters with wildlife are also superimposed on virtually every aspect of TAPS operations. While a majority of these hazards are present at the pump stations and the Valdez Marine Terminal, many also exist along the mainline in conjunction with routine maintenance or repairs. TAPS personnel represent the primary category of impacted individuals. However, impacts may also extend

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9 APSC and the Alaska Department of Transportation both maintain material sites north of the Brooks Range, with such sites available for use by either party.

to other receptors, including the public and the environment.

Various JPO agencies exercise regulatory authority over TAPS operations and require APSC's identification and response to health and safety impacts. APSC's compliance with relevant regulatory requirements has resulted in the development of numerous engineering controls and administrative procedures as well as the use of personal protective equipment and safety devices. TAPS health and safety program elements are contained principally in the TAPS Safety Manual (APSC 2001). The APSC Risk Management Program, developed to satisfy the objectives of the APSC Integrated Management System provides the principal mechanism by which hazards are identified and addressed. The Process Hazard Assessment required by the Risk Management Program results in the development of detailed work plans that govern all routine and nonroutine operations. The review and approval of these work plans guarantee that health and safety impacts to TAPS personnel are identified and that appropriate controls are established.

4.2.3 Impacting Factors Associated with Routine TAPS Operations during the Less-Than-30-Year Grant Renewal Alternative

Section 4.2.2 discusses impacting factors associated with the proposed action — a renewal of the grant for 30 years. This section discusses the impacting factors associated with a renewal of the grant for less than 30 years. The same assumptions underlying the identification of impacting factors from the proposed action would apply to the less-than-30-year renewal alternative. Notwithstanding the incorporation of technological advancements, it is assumed that TAPS would continue to operate in virtually the same manner with no major reroutes; stipulations and controls present in the current grant would be applied to any renewal of the grant; and JPO's oversight authority would remain unchanged.

In general, the impacting factors associated with the proposed action discussed in Section 4.2.2 will also exist during a grant renewal for a period of less than 30 years. Most of the impacting factors identified in Section 4.2 associated with the proposed action (a 30-year grant renewal) would be either continuous (e.g., an existing workpad's influence on surface water flow patterns) or cyclical (e.g., wastes resulting from corrosion control digs or routine maintenance actions) and can be expected to exhibit those same characteristics with respect to the less-than-30-year renewal alternative each time they occur within that shorter time frame. During a less-than-30-year renewal period, impacting factors associated with the existence of TAPS facilities would be continuous and would be the same as those discussed in Section 4.2.1. Likewise, those cyclical events that constitute routine TAPS operations would also result in the same impacts as those identified in Section 4.2.2. Importantly, impacts from some cyclical routine operations do have a temporal component to them that extends the impacts over long periods of time. For example, the dispersion and deposition of air pollutants emitted from pump station and Valdez Marine Terminal equipment are subject to numerous meteorological and terrain influences. While most pollutants have relatively short residence times in the atmosphere (on the order of days for most fossil fuel combustion by-products), some may remain airborne for long periods of time, well after the source that produced them has ceased to operate. For example, carbon dioxide can be expected to have a residence time of as long as 15 years.

While most impacting factors associated with the routine operations of the pipeline, pump stations, and the Valdez Marine Terminal would be expected to be the same over a less-than-30-year period as they are projected to be for the proposed 30-year period of operation, some cyclical events with exceptionally long periodicity might not occur during the less-than-30-year renewal, and, thus, their impacts would not occur. For example, on the basis of current TAPS operating history, pipeline reroutes and main-line valve replacements are less likely to be required over a renewal period substantially shorter than 30 years.

4.2.4 Impacting Factors Associated with Planned Activities under the No-Action Alternative

Section 2.4 broadly outlines the parameters of the no-action alternative. No specific approved plans or designs for termination activities currently exist. Such plans and designs would have to be developed before specific actions could be taken. Any decision on how termination would occur would be subject to further NEPA analysis of the available options. In addition, descriptions of the actions that constitute termination of pipeline operations and restoration are provided in Section 2.4. The following assumptions and conclusions were established to provide a reference point for the identification and analysis of impacts associated with the no-action alternative.

- APSC has the same obligations and liabilities with respect to environmental protection and waste management during termination as it has had during construction and operation of the TAPS (see Federal Grant Stipulation 2.2).
- Federal and state regulations applicable to specific termination activities as well as the provisions of all operating permits will be enforced.
- The issuance of all necessary new or modified federal and state permits will be facilitated; however, performance standards and prescriptive requirements will not be relaxed.
- APSC continues to have liability and responsibility to respond to all accidental releases of crude oil, refined product, or hazardous materials occurring as a result of termination activities or discovered during termination and to undertake remediation of impacted environmental media to the satisfaction of the appropriate JPO member agencies.

Termination of TAPS Operation

"Termination" is not explicitly defined in the Federal Grant. Here the term is used to define all activities occurring after cessation of crude oil transmission. It is anticipated that termination activities will involve a two-year period of planning and environmental review followed by implementation occurring over a four-year period. However, remediation of environmental damage resulting from accidental releases of crude oil, refined petroleum product, or hazardous materials that occurred during TAPS operations or during termination may extend for a longer period of time.

4.2.4.1 Stoppage of Product Flow and System Cleaning

In general, termination activities would start at PS 1 and progress south to allow for transport of cleaning products from one station to the next and finally to the Valdez Marine Terminal. Initially the pipeline would receive batches of oil from North Slope drill rigs, piping carriers, pipelines that deliver oil from the drill rigs to the Central Processing Facility to TAPS PS 1, pump station sumps, tank bottoms, and low-point piping.

Once the last crude oil flow has reached the Valdez Marine Terminal, batches of diesel fuel would be introduced into the pipeline to remove residual crude oil. These batches of diesel fuel would be ultimately received at the Valdez Marine Terminal.[10] Then a mixture of seawater and cleaning solution (e.g., alkaline solutions with chemicals such as trisodium phosphate or nonaqueous surfactant) would be introduced. This mixture would also be received and treated at the Valdez Marine Terminal BWTF before ultimate discharge to Prince William Sound pursuant to NPDES permit requirements. Finally, air compressors would be connected by

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10 Kerosene may also be used instead of diesel fuel. In either case, these rinsates will probably be eligible for incorporation into the crude oil product still stored at the Valdez Marine Terminal.

manifold to the pipe to propel a displacement pig through the pipe to remove the seawater and cleaning solution. This sequence would be repeated at each pump station in succession from north to south (TAPS Owners 2001a).

Under the no-action scenario, aboveground pipe would be removed to 1 ft below grade, and the belowground pipe would be capped. However, it is reasonable to expect that buried segments may nevertheless be excavated in certain locations for system cleaning. Excavations are likely to be necessary to remove the three mainline refrigeration units. Excavation and removal of buried check valves and RGVs can also be anticipated. Removal of buried valves will provide the opportunity for JPO authorities to visually inspect the inside of the pipeline to verify adequate degrees of cleaning. Further, removal of valves provides a convenient point at which temporary manifolds could be installed, through which compressed air can be introduced to displace the final volumes of the pipeline cleaning agent or to propel cleaning pigs. Excavations of buried pipeline in low areas may also be necessary for purposes of visual inspection, complete removal of cleaning agents, or introduction of final cleaning pigs.

The extent to which any such excavations of buried pipeline will be necessary to accomplish satisfactory levels of cleaning, visual inspections, or sealing (capping) of pipeline segments in satisfaction of federal DOT regulations will be determined by JPO authorities overseeing termination activities. Impacts from each such excavation are expected to be similar to those encountered during corrosion digs or valve replacement actions, although the scale of the impacts may be somewhat larger. Impacts include disturbance of land surface of an areal extent of at least 50 by 200 ft per occurrence, impacts to surface waters due to altered drainage patterns, excavation dewatering, and increased potential for siltation. Impacts to air quality and noise would result from the operation of vehicles and excavation equipment. Temporary air compressors that may be installed would also impact air quality and noise. It is anticipated that the original grade of the workpad would be restored after all emptying and cleaning activities are completed at each excavation point. All impacts would be of relatively short duration, lasting perhaps as much as two weeks at each location selected for excavation of the buried pipeline.

Impacts from stoppage of product flow and system cleaning would be similar to those encountered during previous facility rampdown actions at some pump stations and the topping plants. Impacts include the generation of substantial amounts of industrial wastes from the removal of sludge from equipment; removal of tank bottoms, scale, and condensates from storage vessels, dead legs, and transfer piping; removal of cooling fluids from refrigeration systems; and removal of heat transfer fluids and lubricants. Impacts to water resources would result from short-term increases in water demands for equipment cleaning and increased worker populations. Water resources would also be locally impacted from increased amounts of sanitary wastewaters from personnel housing and cafeterias. Wastewaters generated as a result of equipment cleaning are likely to be delivered via the pipeline to the Valdez Marine Terminal for treatment at the BWTF. Air quality and noise impacts would result from increased vehicle traffic. Little to no impacts are anticipated to the terrestrial environment since all activities related to emptying and cleaning TAPS equipment would occur for the most part within structures (i.e., the pump stations or the Valdez Marine Terminal) or on established mainline workpads or existing graveled or paved areas of the pump stations and the Valdez Marine Terminal.

4.2.4.2 Removal of Aboveground Facilities

Dismantling of the aboveground portions of the pipeline, the pump stations, and the Valdez Marine Terminal is assumed to start in 2004 and continue for three years. The final year consists of demobilization (TAPS Owners 2001a). The following TAPS components would be removed: aboveground pipeline segments; remote aboveground valves, power modules, and fencing; aboveground river crossing structures (except the Yukon River Highway bridge); aboveground pipe passing through culverts and road crossings (e.g., converting culverts to low-water crossings and removing workpad bridges); and aboveground pipe adjacent to river training structures. All pump station piping, equipment, buildings, and tanks as well as all mainline refrigeration equipment and buildings would be removed. All aboveground fuel gas piping and mainline refrigeration piping would also be purged, cleaned, and removed. Microwave repeater stations and equipment would be removed. VSMs would be cut off to 1 ft below grade and capped. Heat pipes installed in some of the VSMs would be removed.[11]

At the Valdez Marine Terminal, all aboveground piping, tanks, and concrete containment walls would be removed. All power generation and vapor control facilities, including incinerators, would be removed. The BWTF, including concrete tanks and aboveground structures, would be removed. Finally, all buildings and cable trays would be removed. Berths, berth piping, and mooring dolphins would be removed at the mudline.

The existing pipeline workpad and pump station gravel pads are to be maintained during dismantling operations and left in place at completion. River training structures, except where breached to remove pipe, would be left in place. Workpads adjacent to or in the river crossings and floodplains would be removed, if necessary, to reduce sediment impacts into the river. Therefore, a pad constructed of natural river gravel would not be removed if the adjacent stream had comparable materials, whereas fine-grained material in a pad adjacent to a stream would be removed if erosion of the pad material would lead to significant sediment concerns. In addition, communications sites, the fiber-optic system, Dalton Highway, and the Yukon River Highway Bridge would also remain in place.

All aboveground facilities would be removed to 1 ft below grade. Belowground facilities may be left in place with the exception of culverts, pipes in road casings, and pipe adjacent to river training structures. Excavation to cap belowground facilities may require dewatering and erosion control devices. Razing of some structures would also involve emptying and removal of foundation refrigeration systems. If suspected contaminated soils are encountered during excavation or removal of aboveground facilities, APSC would undertake remediation in accordance with a remediation plan approved by the appropriate JPO authority. Most of the equipment and supplies to be used in dismantlement must be imported from outside the state because of the small relative size of Alaska’s construction industry.

Salvage operations would remove all material for in-state or out-of-state recycling or disposal. All surplus and scrap materials must be removed from Alaska except those buried or otherwise disposed of locally. Pipe and other material from the northern part of the line would be taken to the North Slope to be moved by sea lift for ultimate disposal. Fairbanks is the expected staging area for materials removed from the central portion of the pipeline (north of MP 492), with material transported to Seward or Whittier by truck or train. Valdez is the probable staging area for components removed from the southern portion of the pipeline and the Valdez Marine Terminal. However, as much as 120 acres of additional land may be necessary for other interim staging locations during some portion of the dismantlement period to provide for surge control that may be necessary because of transportation delays. APSC-owned material sites or commercially available land may serve as likely interim material staging areas. Port locations for shipment of scrap materials would be Valdez, Whittier, and Seward (TAPS Owners 2001a). All salvaged materials would have to be moved by truck to the appropriate staging area (Norton 2002b).

The principal impacts from pipeline dismantlement include disturbance of ground surfaces with subsequent impacts to surface

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[11] It is assumed that heat pipes can be successfully removed without opening. Therefore, the anhydrous ammonia would not be released to the atmosphere as a result of the removal action. However, anhydrous ammonia is expected to be removed and recovered under a controlled work environment before the metal heat pipes are sold as scrap.

water systems because of altered drainage paths or increased siltation; vegetative clearing on those portions of the ROW that are not wide enough to support the termination activities; consumption of substantial amounts of fuels for vehicles and construction equipment (including vehicles used to haul pipeline components to accumulation points pending final disposition), with subsequent localized air quality and noise impacts; increased amounts of fugitive dust; increased water withdrawals for domestic uses, principally to support substantial increases in workforce personnel; increased water withdrawals for industrial use (cleaning); increased volumes of domestic solid wastes and sanitary wastewaters, with proportional changes to current impacts to surface water, air quality and land from the subsequent management of those solid wastes and wastewaters. Further, new or different impacts can be expected from the solid wastes and wastewaters generated during dismantlement since many of the systems currently in use to manage these wastestreams would no longer be operational (e.g., the turbine exhausts used to evaporate sanitary wastewaters at PS 1, 3, and 4; or the incinerators that burn nonhazardous solid wastes at the pump stations and the Valdez Marine Terminal). Some special industrial wastes will also result from the dismantlement of infrastructure that contains asbestos, mercury, PCBs, or radioactive species; however, quantities of such special wastes will be limited. There may be local impacts to surface water from dewatering of the limited number of excavations that would also be necessary as part of dismantlement of aboveground systems.

Cultural resources may also be impacted by the dismantling of equipment and structures should the TAPS be determined an eligible historic property.

4.2.4.3 Revegetation and Restoration

After removal of aboveground facilities, the cleared land would be contoured and revegetated. Restoration of some areas may also involve importation of fill materials to establish appropriate grades. Revegetation activities must be performed in accordance with requirements of the Federal Grant. In the past, follow-up monitoring was normally conducted for five to seven years following the revegetation activities to ensure erosion control. Short-term, localized impacts may result from increased vehicle and equipment activities and human presence. Impacts include impacts to air quality, noise, increases in fugitive dust, alteration of surface water flow patterns, erosion, and sedimentation, and some minor disturbance of existing vegetation. Off-site impacts may also result if importation of fill materials is required.

Subsidence can be anticipated as a long-term impact in some segments of buried pipeline that are abandoned in place. Subsidence will occur when advanced corrosion causes loss of structural integrity of the 4-ft-diameter pipe to a degree where it can no longer support the weight of the overburden. For example, subsidence along segments of pipeline abandoned below river crossings may dramatically alter surface and subsurface water flows. However, previous experiences with abandoned underground pipe segments (e.g., Atigun Pass) suggest that natural processes (e.g., siltation buildup inside the pipe) will diminish the potential impacts of subsidence events. In addition, segments abandoned in thaw-unstable permafrost (i.e., the previously refrigerated segments) will be subject to frost heaving because they are not anchored and no longer have the weight of the oil to help resist frost movement.

4.2.4.4 Health and Safety Impacts Associated with the No-Action Alternative

Health and safety impacts associated with the stoppage of crude oil flow, emptying, and cleaning of TAPS are essentially equivalent to the impacts associated with routine operations that were discussed in Section 4.2.2.7. Many of the actions to empty and clean equipment that would be performed under this first phase of termination are virtually equivalent to the routine cleaning and maintenance of that equipment that occurred during TAPS operations. However, some additional activities unique to termination can also be anticipated, especially in those instances where the existing system would need to be modified to support a cleaning activity (e.g., the addition of compressors for introducing compressed air for final emptying and cleaning). Further, since cleaning involves the introduction of alternative substances into the TAPS system than those for which it was designed (diesel fuel as an initial rinsing agent, followed by seawater that includes detergent additives), the operational hazards would be somewhat different than those encountered during routine operations. However, the Risk Management Program established within the TAPS Safety Manual (APSC 2001) would still provide an appropriate venue for identifying and addressing these new risk factors. As with normal operations, TAPS personnel and contractors would be the principal population segment impacted by hazards associated with cleaning and emptying of the TAPS.

The final phases of the no-action alternative, removal of aboveground structures, would present fundamentally different health and safety hazards from those associated with routine TAPS operations but would be very similar to hazards encountered during pipeline rerouting or replacement activities, only at a substantially larger scale. The nature and scale of health and safety impacts for dismantlement would be virtually equivalent with impacts from initial TAPS construction. Principal impacts include those routinely associated with major construction projects: heavy machinery operations, vehicle traffic, overhead lifting, open flame work, handling of fuels and lubricants, trip and fall hazards, electrical hazards (from portable power generation as well as the use of power tools), and high noise environments. As with all outdoor work in Alaska, natural elements as well as wildlife are omnipresent health or safety impacts. Most impacts will primarily affect the construction workforce. However, environmental receptors may also be impacted. In more populated areas, human receptors may also be potentially impacted.

4.2.5 Nonroutine Factors — Spills Hazards under the Proposed Action

Unlike routine pipeline operations where actions are planned and deliberate, spills of crude oil, refined petroleum products, or other environmentally hazardous substances are unplanned events that have both natural (e.g., seismic) and anthropogenic initiators (e.g., equipment failure [including that caused by corrosion] and human error). The spills analysis for this DEIS covers crude and other product spills triggered by events impacting pipeline, Valdez Marine Terminal, Prince William Sound, and North Slope operations. The spills for Prince William Sound and North Slope are covered as cumulative impacts in this DEIS. Spill scenarios to assess impacts during the ROW renewal period of the TAPS and for the no-action alternative were developed for four groups of likelihood of occurrence categories: "anticipated," "likely," "unlikely," and "very unlikely." The spill scenarios developed for this DEIS are discussed and presented in Section 4.4.1. The primary impacting factors on which that analysis is based are discussed below.

In assessing spill impacts for the proposed action alternative, it is assumed that TAPS facilities will operate at three throughput levels, with the minimum 300,000 bbl/d, the maximum 2.1 million bbl/d, and a nominal operating level of 1.1 million bbl/d (see Appendix A). The assessment assumes a 30-year renewal operating period. During this time, major activities will involve the continued pumping of oil from the North Slope to the Valdez Marine Terminal with four to seven operating pump stations, oil production from the North Slope fields, operations of facilities at the Valdez Marine Terminal, and marine transportation through Prince William Sound.

4.2.5.1 Natural Events

Nine natural spill initiators were initially considered in the spills analysis: (1) seismic events, (2) flooding/washout, (3) volcanoes, (4) lightning, (5) wildfires, (6) settlement/ subsidence, (7) landslides and avalanches, (8) tornadoes, and (9) tsunamis. Analysis of frequencies of spill events resulting from volcanoes, lightning, wildfires, tornadoes, and tsunamis were deemed not credible and therefore screened from further analysis. Spill events involving earthquakes, washout, settlement, and landslide were determined to be "credible" (with frequency of spill occurrence more likely than one chance in one million, see Appendix A, Section A.15.2) for the pipeline. Except for washout and settlement, these same initiators were determined to be credible spill events for the Valdez Marine Terminal. The spill volumes and frequencies from assessed spill initiating events are discussed in Section 4.4.1. There were no spill scenarios for Prince William Sound and the North Slope involving initiation by a natural event.

The “washout” event is defined as a washing away of earth in areas where the pipeline passes under or near a stream or river. Washout pipeline damage (e.g., small cracks in the pipe associated with dents or deformities) could occur because of its close proximity to a stream or river. Impacts to TAPS structural systems from washout events were considered during the design phase in accordance with Federal Grant Stipulation 3.6.1. Nevertheless, the VSMs on aboveground pipeline segments could potentially be impacted. The stability of VSMs at river crossings could also potentially be impacted by bank erosion, channel migration, or channel scouring that may be a natural follow-on consequence of washout events (see Section 4.2.2.5.3.) Data from 1987 through 1998 show the occurrence of 12 pipeline “washout” spill events in the lower 48 states. (DOT 2001). The events resulted in medium to small cracks in the impacted pipelines. Although no leaks have resulted from washout in the history of the TAPS, it was assumed that the pipeline could be susceptible to damage if it was located in a floodplain region that is subject to washout.[12] The estimated spill frequency using this approach results in conservative frequency estimates compared with the DOT OPS data. The washout spill hole sizes used in estimating spill volumes are in reasonable agreement with sizes estimated from DOT OPS data for actual washout-initiated spill events that occurred primarily in the contiguous United States.

Review of available data on seismic events revealed that the six largest earthquakes that have occurred in the United States took place in Alaska. Three of the largest Alaska quakes rank in the top 10 of earthquakes occurring worldwide from 1904 through 1992. These three events occurred in 1957, 1964, and 1965. The 1964 earthquake-generated tsunami leveled the town of Valdez with a Moment-magnitude 9.2 M (8.2 to 8.7 on the Richter scale), the second largest seismic event ever recorded (AEIC 2002). Stipulation 3.7 of the Federal Grant requires a consideration of the possible recurrence of such an event in design decision. The TAPS is divided into seismic zones with different seismicity levels; the highest levels are in the Chugach and Alaska mountain ranges and the lowest on the North Slope.

Landslide-initiated events were identified as a credible hazard to the pipeline on the basis of two observations: (1) landslides were experienced in the 1964 earthquake, and (2) landslide-susceptible soils are found along the pipeline. Specifically, colluvial soil of landslide origin was reported by Kreig and Reger (1982). Other colluvial soil and alluvial fan soil can be seen in aerial photographs of the pipeline route (R&M Engineering and Geological Consultants 1974). These are limited to the mountainous regions. Generally, landslides would not be an area of concern for the buried pipeline; however the depth of burial would not be sufficient to place the pipe entirely below the susceptible soil. Further, landslides could result in amounts of soil deposited above a buried segment that could exceed the design specification for overburden weight, thereby leading to crushing deformities in the pipe. In some instances, the pipeline could survive landslide motion. A very site-specific analysis would be required to make this judgment. Anecdotal evidence suggests that, in most instances, pipelines do not survive ground displacement associated with a landslide (Nyman 2001). Therefore, the spills analysis presented in Section 4.4 assumes that a landslide will result in a guillotine break.

Settlement or subsidence has initiated two crude oil spills during TAPS operations, both occurred in 1979, one near Atigun Pass and the other at PS 12. Although crude oil spills occurred

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[12] The estimated TAPS spill frequency due to washout was estimated using the 95% confidence limit for a binominal distribution with an adjustment factor of 1 or 0 for susceptible and nonsusceptible pipeline regions (Capstone 2001).

only in these two locations, investigation conducted in the late 1970s identified eight additional locations where the pipe showed signs of buckling curvature. In addition, vertical settlement of a segment of buried pipeline and solifluction (downslope creep) have led to problems of alignment with the adjacent aboveground pipe segment.

4.2.5.2 Human Events

Human spill initiators can be either direct or indirect. Direct human events are either caused by accidents involving transportation vehicles, such as trucks or aircraft, or intentional acts of vandalism or sabotage. Indirect human events are caused by equipment failure or human error.

A total of 12 direct human-initiated spills were assessed in this DEIS, 11 spills resulting from transportation vehicles and 1 spill from a deliberate act of vandalism/sabotage. The transportation events included impact to the pipeline from a truck and an aircraft. For security reasons, detailed scenarios involving deliberate acts of vandalism or sabotage are not specifically identified. Such events, for example, could include the use of an explosive device similar to the 1977 Steele Creek attack to the pipeline, or the random act of pipeline vandalism with a high-powered rifle that occurred near Livengood in the fall of 2001. Analysis of frequencies of spill events resulting from ship or boat impacts along river crossings for the pipeline and at the Valdez Marine Terminal berths indicated that these events were not credible, and they were, therefore, screened from further analysis. However, analysis of frequency data that could involve failure in the loading arms for tankers at Valdez Marine Terminal berths shows this spill scenario would be a credible event. Truck and medium-to-large aircraft crash events were determined to be credible for the pipeline. A medium-to-large aircraft crash into the East Tank Farm was deemed to be the only credible human-initiated event for the Valdez Marine Terminal.

Spill initiators for the pipeline that were determined by frequency analysis to be credible included maintenance-related damage, valve leaks, corrosion, and over-pressurization because of RGV closure. The spill events analyzed in detail for the Valdez Marine Terminal included a tanker vessel crack, fuel line rupture, pipeline failure, and catastrophic ruptures in crude storage and diesel fuel tanks.

All of the spill scenarios assessed under the cumulative impacts for Prince William Sound and the North Slope were the result of indirect human initiators. Five spill events caused by collisions between ships or vessels (tankers) or with other obstacles, drift grounding, vessel structural failure or foundering,[13] power grounding, and fire/explosion occurred at six locations within Prince William Sound. This combination of spill causes and location resulted in 30 of the 34 spill scenarios evaluated for Prince William Sound. The other four were small-to-moderate crude oil and diesel fuel spills occurring during TAPS operations. The North Slope scenarios included six spill events caused by a well blowout, four pipeline ruptures, and a spill occurring at a drilling platform. An additional six small-to-moderate spills involving crude oil, diesel fuel, and saltwater were assessed as anticipated during the TAPS ROW Federal Grant renewal period.

4.2.5.3 Changes to Impacting Factors for Nonroutine Events as a Result of Planned Pump Station Upgrades and Modifications.

Section 4.2.2.6.3 provides the details of proposed upgrades to pump stations and modifications to the Valdez Marine Terminal. If pursued, these proposed changes may result in changes to impacting factors for nonroutine events such as spills. Section 4.2.5.1 identifies the natural processes that can serve as initiators of credible spill events. There is no basis for any argument that the proposed upgrades will affect the probability or frequencies of those natural events. However, modifications to the pump stations may result in different consequences for spills caused by natural processes. In general, the simplification of equipment at some pump stations as well as the complete elimination of pump-station-related equipment at other pump stations can be expected to result in potentially

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13 Vessel foundering is defined as the loss of stability because of water ingress.

less consequence of a spill caused by natural processes, especially in those instances where the natural event can be seen as affecting the integrity of engineered systems at those pump stations. For example, eliminating the need to store turbine fuel at pump stations where the new turbine pumps are driven by electric motors eliminates the possibility of spills of fuel from on-site storage tanks as a result of a natural event such as an earthquake. Further, pump stations that are completely eliminated would be replaced by an RGV. Thus, elimination of a pump station would not result in an increase of the static volume of oil available for release as a result of a mainline break on either side of the former pump station.

Section 4.2.5.2 describes the possible human initiators for credible spill events. In these instances, simplification or elimination of complex mechanical systems and automation of remaining mechanical systems may result in lower probabilities of occurrence for some human initiators such as operator error or equipment failure. Further, by much the same argument as advanced above for natural process-initiated spills, simplified or eliminated mechanical systems can be expected to lower the consequence of any spill initiated by human factors.

4.2.6 Impacting Factors Associated with Nonroutine Events — Spills during the Less-Than-30-Year Renewal Alternative

Impacting factors associated with nonroutine events would be the same whether the renewal period was 30 years or less. However, some factors can be shown to have nonlinear, time-dependent characteristics, depending on the initiators. Section 4.2.5 identifies the natural and human initiators associated with credible spill events. The time dependence of these factors and their effect on frequency and volume of spills along the pipeline, at the Valdez Marine Terminal, at the North Slope, and during tanker transport through Prince William Sound are discussed in Section 4.5.1.2.

4.2.7 Nonroutine Factors Associated with Unplanned Events: Spills during the No-Action Alternative

Under the no-action alternative, prior to dismantlement and removal of the TAPS, the remaining crude oil would be purged from the pipeline. Purging would be implemented using kerosene or diesel fuel as a solvent to clean the pipe.[14] The final purge would be with seawater. The pipeline purge process is estimated to take as long as 90 days. For a relatively short time, termination activities would disrupt the terrestrial environment and result in an increased potential for spills.

4.2.7.1 Natural Events

Purging the remaining crude oil from the pipeline and completing cleaning of the pipeline would take a relatively short time. Comparing the time expected to complete this phase of termination with the frequency of natural occurring events that can act as spill initiators described in Section 4.4, a pipeline or Valdez Marine Terminal spill of crude oil or rinsing agent would have a probability of occurrence of less than one in one million. Such events would be “incredible” and were not considered.

4.2.7.2 Human Events

Human spill initiators can be either direct or indirect. Direct human events are either caused by accidents involving transportation vehicles, such as trucks or aircraft, or intentional acts of vandalism or sabotage. Indirect human events are caused by equipment failure or human error. Indirect human actions have been shown by APSC risk analyses to be the most likely cause of spill events. Spill volumes and frequencies for a total of five diesel oil spill scenarios are described in Section 4.6.1.2 for the no-action alternative.

14 The presence of detergents may affect the strategy employed to respond to a release of this rinsate. However, the relatively short duration of this activity still argues for a release of rinsates to be a low-probability event.

4.3 Proposed Action Alternative Analysis — Routine Operations

4.3.1 Physiography and Geology

The interaction between geologic processes and the continued operations of the TAPS would impact the local environment adjacent to the TAPS. The impacts would be further complicated by the current warming trend of the climate that may affect the TAPS. Because the TAPS has been in operation for more than 25 years, most of the current impacts have been observed (see Section 3.2) and have become part of the existing environment. In the following paragraphs, additional impacts from continuing the operation of the TAPS for the proposed action are described.

Impacts of Proposed Action on Physiography and Geology

The impacts on physiography and geology are expected to be localized near the TAPS. Impacts of mass wasting processes would be mitigated as in the past.

Activities that would impact the physiography and geology include (1) creating new or expanding existing operation material sites (OMSs) to mine sand, gravel, and quarry stones; (2) using the material to maintain workpads, access roads, and to protect the pipeline from shore erosion; and (3) conducting any relocation of the pipeline, if needed. Most of these activities would be carried out for maintenance. The impacts to the physiography and geology would result from changes to landforms and removal of geological material. As compared to the scale of the landscape crossed by the TAPS, the change to landforms caused by the construction and operation of the pipeline would be insignificant. The removal of geologic material would also be very small relative to the availability of the material, and the removal would be spread over a few new and 69 old OMSs across 800 mi. Therefore, the impacts on the physiography and geology are expected to be very localized near the TAPS.

Modification of the geological processes along the TAPS would continue under the proposed action alternative. Historically, soil erosion, ponding, flooding, and thawing of permafrost near workpads, access roads, and quarries occurred locally. These processes would continue to occur on a localized scale near the TAPS.

Under the proposed action, the impact of mass wasting processes on the pipeline would continue and expand, especially on sloped areas, as evidenced at various sites along the southern ROW (see examples listed in Section 3.3.2).

Historically, the effects of mass wasting processes on the TAPS have been mitigated through rerouting a section of pipeline; using passive thermal-transfer devices (pipes to remove heat from the soil in winter) for the vertical support members; using insulated boxes and refrigeration for buried pipes at locations where the underlying soils are thaw-unstable; applying wood chips on workpads for insulation; using “smart pigs” to detect anomalous curvature of underground pipeline; and instituting vigilant surveillance, monitoring, and maintenance. Under the proposed action, similar types of mitigation measures would continue. The impacts of any mass wasting processes on pipeline integrity would be mitigated as in the past.

4.3.2 Soils and Permafrost

Excavations for pipeline rerouting, corrosion digs, valve replacements, buried pipe repairs, and pipeline coating refurbishment are part of routine maintenance for the TAPS. Historically, excavation has destroyed local surface vegetation and impacted the soils and permafrost, producing drainage, surface subsidence, ponding, and slope stability problems. The impacts have been local,

Impacts of Proposed Action on Soil and Permafrost

The impacts on soil and permafrost caused by routine maintenance activities (i.e., excavation, disturbance) would be localized and would not increase significantly in magnitude or number from those experienced historically from pipeline operations. With the continuous warming trend in Alaska, the risk of earthquake-triggered liquefaction and landslides would be expected to increase. These events, although very unlikely, could potentially threaten the integrity of the TAPS.

occurring immediately adjacent to the ROW and access roads (Figure 4.3-1). Under the proposed action, these types of excavations would continue (Table 4.3-1). Their associated impacts would be about the same as those seen historically, and the affected areas would be of the same localized scale.

In addition to the effects of the excavation itself, the environment has been affected by the use of heavy equipment and trucks in upgrading pump stations (see Section 4.2.2.6.3) and maintaining slopes, VSMs, and workpads. The impacts have been local and include the destruction of vegetation cover and an increase in soil erosion and siltation. Under the proposed action, these types of impacts would continue. They would continue to be localized and would not increase significantly in number or magnitude.

The buried pipeline has also affected adjacent permafrost by heat transfer. Heat from the warm oil in the pipeline creates thaw bulbs (areas where the frozen soil is melted) along the ROW. The sizes of the thaw bulbs depend on the throughput of the pipeline. The shrinking and growing of thaw bulbs could promote frost heaving and settlement, respectively, near the TAPS. The current throughput of the pipeline is about 1.1 million bbl/d (TAPS Owners 2001a). If the throughput in the pipeline were to decline to 0.3 million bbl/d, the heat input into the subsurface would decline. The thaw bulbs that have developed around the buried pipe would shrink because the pipeline temperature would decrease with decreasing throughput. Shrinkage of the thaw bulbs could then promote permafrost aggradation. Ground ice could grow, producing frost heave in some areas, especially in areas where fine-grained soil is dominant in the subsurface. Historically, the decline in throughput has had an insignificant impact on the integrity of the pipeline due to contraction of the thaw bulbs. Continued monitoring and maintenance would identify areas where heave might exceed operational standards, and repairs could be made accordingly. If the throughput of the pipeline were to be increased from 1.1 to 2.1 million bbl/d, the thaw bulbs could expand, and ground settlement could resume. The expansion and contraction of the thaw bulb is a local phenomenon.

The general retreat of glaciers along the TAPS, the enlargement of thermokarst lakes near Fairbanks (Chatanika River at MP 440), and increased near-surface soil and permafrost temperature in the southern part of the TAPS ROW may indicate a trend of a warming climate in the last 25 years along the TAPS. In an area near the southern margin of the permafrost (MP 735–736), previous permafrost has thawed (Keyes 2002). General warming along the TAPS would promote increasing average temperature of the soils, melting of ground ice, release of meltwater, and lowering of the permafrost table. The resulting effects would lower the mechanical strength of frozen to nonfrozen soil and promote solifluction, debris flows, rock falls, potential landslides, differential settlement, liquefaction, and alternation of local hydrology. These processes would continue to impact the integrity of the TAPS, if not carefully monitored and managed. In addition, the increased soil temperature would compound the impacts from any soil disturbance and expansion of the thaw bulbs with increased throughput of the pipeline.

The potential for liquefaction of soils and landslide is closely related to the water or moisture content of soils. As a frozen soil is subjected to warming and the contained ground ice melts, the liquid water content in the soil increases. If the water is prevented from draining because of the presence of underlying permafrost or other reasons, the soil becomes saturated and its mechanical strength is

Click here to view Figure 4.3-1

FIGURE 4.3-1 Ponding and Change of Local Surface Hydrology Adjacent to the TAPS ROW on the Arctic Coastal Plain

TABLE 4.3-1 Potential Impacting Factors of the Proposed Action on Soil and Permafrost

- Replacing or repairing buried, refrigerated portions of the pipeline
- Replacing or repairing buried valves at the rate of no more than 5 valves per year
- Installing new impressed-current rectifiers and repairing, replacing, or improving 6 to 10 anode grid beds per year
- Refurbishing pipeline coating for up to a total of 5 mi
- Maintaining workpad slopes
- Removing sand, gravel, and quarry rock from borrow sites at a rate of approximately 100,000 yd^3 per year
- Repairing, replacing, and installing river training structures

weakened. This weakening can be significant in soils composed of loosely packed silt or flocculated clay with a high content of ground ice. When these soils are shaken by strong ground motions during an earthquake, liquefaction may result. Similarly, saturated soils on slopes are weak mechanically. The permafrost table under those saturated soils could provide a potential plane for a landslide to occur. A landslide could be additionally facilitated by ground shaking in an earthquake. Both soil liquefaction and landslides could threaten the integrity of the TAPS.

The potential for liquefaction of soils and landslide is closely related to the water or moisture content of soils. As a frozen soil is subjected to warming and the contained ground ice melts, the liquid water content in the soil increases. If the water is prevented from draining because of the presence of underlying permafrost or other reasons, the soil becomes saturated and its mechanical strength is weakened. This weakening can be significant in soils composed of loosely packed silt or flocculated clay with a high content of ground ice. When these soils are shaken by strong ground motions during an earthquake, liquefaction may result. Similarly, saturated soils on slopes are weak mechanically. The permafrost table under those saturated soils could provide a potential plane for a landslide to occur. A landslide could be additionally facilitated by ground shaking in an earthquake. Both soil liquefaction and landslides could threaten the integrity of the TAPS.

Since the pipeline has been operating, no earthquake-triggered landslides or liquefaction events have been reported. This lack of such events might be attributed primarily to the fact that areas with soils prone to liquefaction or landslides were avoided to the maximum extent possible during the selection of the route of the TAPS. Other minor factors might include that (1) no very strong earthquake has occurred near the TAPS in the last 25 years (see Section 3.4), and (2) mitigation measures were implemented to minimize the degradation of permafrost along the TAPS. However, if the warming trend in Alaska continues for the next 30 years of the proposed renewal period, the risk of encountering liquefaction and landslides would be expected to increase.

Accidental spills and leaks can impact the environment, including soils and the permafrost layer along the pipeline. A detailed evaluation of potential spills under different scenarios is provided in Section 4.4.4.1.

4.3.3 Seismicity

Since the TAPS was built, the three largest earthquakes that have been recorded in southern Alaska had moment magnitudes (see Section 3.4) of 7.5 (1979), 7.8 (1988), and

7.9 (1987) (AEIC 2001). The epicenter of each of the three earthquakes was more than 190 mi east or southeast of Valdez. No damage was done to the TAPS by these earthquakes. It is reasonable to assume that future earthquakes of that magnitude in the same general areas would be unlikely to cause damage of the TAPS. However, it is uncertain whether an earthquake as large and as close as the Great Alaska Earthquake of 1964 (also known as the Good Friday Earthquake, 9.2 moment magnitude) would damage the TAPS. The epicenter of the Great Alaska Earthquake was about 60 mi west of Valdez, and the quake caused extensive ground cracks and landslides in the Chugach Mountains and the southern edge of the Copper River Lowland area (Ferrians 1966). If an earthquake-triggered landslide or ground cracking occurred in an area crossed by the TAPS, the integrity of the pipeline would likely be threatened. The pipeline was not designed to withstand a landslide, although previous landslide areas were avoided to the extent possible when the pipeline was constructed.

Seismicity-Related Impacts

Earthquake-triggered landslides and soil liquefaction are credible threats to the integrity of the pipeline if another earthquake as large and as close as the Great Alaska Earthquake of 1964 were to occur.

Similarly, earthquakes might also have the potential to trigger liquefaction (see Section 4.3.2) and cause the loss of support of the pipeline. Both cases might result in release of oil from the pipeline to the surrounding environment.

4.3.4 Sand, Gravel, and Quarry Resources

The volume of sand, gravel, and quarry stone required for workpad repairs, roadbed and surface materials, and flood damage control is estimated to be less than 100,000 yd^3/yr (TAPS Owners 2001a). If the Federal Grant for the ROW was renewed for 30 years and the TAPS continued operating, most of the required materials would be obtained from the 69 OMSs. However, development of new OMSs to help meet the materials requirements is possible, and the work limits of some existing sites would be expanded. The main impact of sand, gravel, and quarry stone mining would be resource extraction.

Impacts of Proposed Action on Material Use

Under the proposed action, impacts from the use of sand, gravel, and quarry stone would be expected to be similar to those observed historically.

Other environmental impacts associated with the extraction would be minor modification of local topography, loss of surface vegetation, creation of landscape scars, and a temporary increase of soil erosion and siltation near the OMSs. In some OMSs, destruction of permafrost would produce ponding. Historically, these impacts have been localized and small. Because the use of sand, gravel, or quarry stone for the proposed action would be similar that occurring historically during TAPS operation, the impacts would be expected to be similar as well.

4.3.5 Paleontology

The renewal of the Federal Grant is not anticipated to adversely affect known paleonto-logical resources. All previously discovered Pleistocene fossils were removed at the time of discovery, although smaller, pre-Pleistocene fossils may still be found in soils and rocks within the TAPS ROW and associated areas. New discoveries have been made close to the ROW. Eleven registered paleontological sites (from Alaska Heritage Resources Survey files) were found within a quarter mile of the TAPS ROW and associated materials sites.

APSC is required under Federal Grant Stipulation 1.9.2 to contact the JPO Authorized Officer and an archaeologist (who would, in turn, contact a qualified paleontologist) if any known or previously undiscovered paleontological resources are encountered during TAPS-related activities. Alaska's Historic Preservation Act 41.35 also protects paleontological resources that may be encountered along the ROW on state-administered land.

Impacts of Proposed Action on Paleontological Resources

Renewal of the Federal Grant would not be expected to have an adverse effect on any known paleontological resources. All Pleistocene fossils that were discovered in the ROW were removed at the time of discovery. APSC would be required to implement specific protective measures for any additional paleontological resources discovered during pipeline operations.

4.3.6 Surface Water Resources

The TAPS could cause impacts to surface water resources during normal operations for the proposed action. Surface waters along the ROW could also impact the pipeline. The impacts could be direct or indirect. Impacts from accidental releases are discussed in Section 4.4.4.3.

4.3.6.1 Impacts to Surface Water along the TAPS ROW

The continued presence of the pipeline and its continued maintenance for the next 30 years could affect surface water resources along the TAPS ROW. Specific direct impacting factors anticipated for the proposed action include the following:

- Dewatering 15 to 20 corrosion repair sites per year that would release an annual total of 500,000 gal of water to the environment;
- Replacing or repairing buried, refrigerated portions of the pipeline that would potentially require disposing of water encountered;
- Replacing or repairing buried valves at a rate of no more than five valves per year that would potentially require disposing of water encountered;
- Installing new impressed-current rectifiers for cathodic protection and repair, and replacing or improving 6 to 10 anode grid beds per year;
- Refurbishing pipeline coating for up to a total of 5 mi of pipeline that would potentially require excavation dewatering over a 30-year period;
- Draining secondary containment structures along the TAPS ROW;
- Discharging hydrostatic-test water;
- Maintaining workpad slopes;

Impacts of Proposed Action on Surface Water Resources

Direct impacts to surface water resources along the TAPS ROW could occur through continued water use to support operations. None of the activities of the proposed action would require use or disposal of more water than the amounts used or disposed of historically by TAPS operations. Historically, surface water use and disposal have represented a very small fraction of the total quantity of water available along the TAPS ROW and have been regulated under Alaska regulatory permits. Impacts from these historical uses and disposals have, thus, been small, local, and temporary. Because water use and disposal activities under the proposed action would be about the same as those that have previously taken place, impacts from the proposed action would be small, local, and temporary.

Indirect impacts to surface water resources could occur by discharge of water from operations to the land, with subsequent runoff to nearby surface water bodies. None of the activities of the proposed action would dispose of more water than the amounts that were disposed of historically. Impacts from the historical land discharges have been local and temporary and regulated by appropriate discharge permits. Because the quantity of water that would be discharged to the land for the proposed action would be similar to the quantities discharged historically, impacts to the surface water bodies would also be similar.

- Removing sand, gravel and quarry rock from borrow sites for workpad repairs, road bedding and surface materials, and flood damage control and revetment projects at a rate of about 100,000 yd^3 per year;

- Repairing, replacing, and installing river training structures;

- Using surface water for drinking, cooking, and personal hygiene at manned facilities; equipment washing; dust abatement on roads and workpads; hydrostatic testing; MCCFs; and other special projects (see Section 3.7.2.3); and

- Discharging wastewater to land at PS 5 and MCCFs.

For those activities involving dewatering of excavations made to repair corrosion problems, the maximum release of water would be 250,000 gal per event (but not to exceed 500,000 gal per year total). This volume of water is independent of the three pipeline throughputs evaluated for the proposed action (0.3 million, 1.1 million, and 2.1 million bbl/d [see Section 4.2]). As discussed in Section 3.7.2.5, water discharge from dewatering operations has been regulated through various permits, beginning with a State of Alaska wastewater discharge permit in 1983. The current linewide permit requires notification, volume estimates, and descriptions of procedures used to minimize erosion and the discharge of pollutants (see Section 3.16.4). Between 1993 and 1999, 12 such releases were made to water; the total volume of water released was approximately 1 billion gal, with a maximum annual discharge of 800 million gal in 1996 in 25 separate activities (TAPS Owners 2001a), including dewatering excavation sites. In 1997, more than 600 secondary drainage structures along the ROW were drained. The total volume of water released was 15,678,000 gal. Most of this water came from early summer dewatering of the tank farm at PS 1, where the secondary containment volume is the greatest. Because these releases have had only local and temporary impact on surface water resources along the TAPS ROW (see Section 3.7.2.5) and because there have been no formal NPDES incidents of noncompliance, continued operation of the pipeline would be expected to produce similar impacts.

> **Cathodic Protection**
>
> Cathodic protection is reduction of the corrosion rate by shifting the corrosion potential at the electrode (pipeline) toward a less oxidizing potential by applying an external electromotive force (DC power supply).

The continued discharge of hydrostatic-test water to the environment could also have adverse impacts on surface water resources. Those impacts are expected to be independent of the pipeline throughput. In 1991, 3.8 million gal of test water was released when more than 8 mi of the pipeline was reconstructed because of corrosion concerns in the Atigun River valley (see Section 3.7.2.5). This water was released under the linewide NPDES permit. If released at a constant rate, the discharge would have been be approximately 7 gal/min. (Flow in the nearby Atigun River has a mean annual value of about 29,000 gal/min [USGS 2002].) The actual rates of release are not known, but are expected to have been somewhat higher than the 7 gal/min average cited above because of seasonal effects (e.g., hydrostatic testing may not occur during the winter), and gravity evacuation may be required. Because the impacts of this release have been small relative to typical stream flows, future impacts from such activities under the proposed action would be expected to be similar — local and temporary.

The activities discussed above could also affect surface water resources by modifying runoff from workpads during slope maintenance. As discussed in Section 3.7.2.5, storm-water runoff is regulated under the EPA Storm Water Multi-Sector General NPDES Permit. Compliance with this permit guarantees that storm-water runoff will have no significant adverse impact on the environment. Similarly, construction activities that disturb more than 5 acres, do not involve excavation dewatering, and have a potential to impact waters of the United States are regulated under the NPDES Permit for Storm Water Discharge from Construction Activities Associated with Industrial

Activity. Specific notices of intent must be submitted to the EPA, and regulations must be followed for projects that meet the criteria for coverage under the permit. Historically, there is no evidence that storm-water runoff from workpads or other areas has produced any measurable harm to the environment. Because continued operation of the pipeline would produce impacts similar to those observed historically, the impacts would be expected to be similar.

During continued operations under the proposed action, approximately 100,000 yd^3 of sand, gravel, and quarry rock would be removed each year from borrow areas near the TAPS ROW. Most of these materials would probably be obtained from the 69 OMSs on public lands for which APSC has mining permits (TAPS Owners 2001a). Removal operations could cause erosion and siltation that could affect surface water resources. Historically, these impacts have been local and temporary. Because the removal rates under the proposed action would be similar to those of the past, their impacts on surface water resources would be expected to be similar.

Proposed action activities could also impact surface water resources through modification of water bodies during repair, replacement, or installation of new river training structures. Erosion and sedimentation in streams and rivers are discussed in Section 3.7.2.1. Although river training structures and their maintenance can impact the associated streams, these impacts are limited to the immediate vicinity of the structure and are temporary, particularly in braided river systems that have very fast and large natural dynamic changes (see Section 3.7). Because continued operations would produce similar impacts to those observed historically, the impacts would be expected to be similar.

Surface water resources along the TAPS ROW could also be affected by the continued use of surface water for drinking and cooking at manned facilities (including pump stations, MCCFs, and other TAPS facilities), equipment washing, dust abatement on roads and workpads, hydrostatic testing, and other special projects (see Section 3.7.2.3). Historically, water use along the ROW has supported a wide variety of pipeline throughputs, ranging from a high of about 2 million bbl/d (maximum capacity of 2.1 million bbl/d) to the current value of about 1.1 million bbl/d of oil (TAPS Owners 2001a). The largest single project for which a temporary water-use permit was issued occurred in 1997. That permit allowed the use of 7.4 million gal of water for tank cleaning and testing at PS 1. This water was withdrawn from East Lake and produced a small, local, and temporary effect. Similar temporary water-use permits have been issued on an as-needed basis. These activities have all produced small and local impacts along the ROW. Because continued operation of the pipeline under the proposed action would use quantities of water similar to or less than those used historically (less water would be required for a 0.3 million bbl/d throughput of oil because some pump stations would be shut down), impacts to surface water resources would be expected to be similar.

Finally, surface water resources along the TAPS ROW would be affected by discharging treated wastewater to land at PS 5 and other MCCFs. As discussed in Section 3.7.2.5, spreading treated wastewater and other release water at MCCFs is regulated under the linewide NPDES permit and the Wastewater General Permit. These impacts have been local and small because of large potential dilution in receiving waters. The impacts are, however, not temporary because they have continued through time. Under the proposed action, discharging treated wastewater to land would continue at approximately the same level as observed historically or increase slightly if stack injection is not possible under low throughputs. Therefore, the associated impacts would be expected to be similar.

4.3.6.2 Surface Water Impacts on the TAPS Pipeline

Historically, surface water has directly affected the TAPS ROW, requiring continued surveillance, regular maintenance, and rapid mitigation response to acute events. As discussed in Section 3.7.2.1, rivers and streams crossed by the pipeline are subject to floods, erosion, debris flows, and sedimentation. In extreme cases, maintaining the integrity of the pipeline required very rapid response and

Surface Water Impacts on the TAPS Pipeline under the Proposed Action

For the proposed action, the pipeline would remain subject to the impacts of flooding, debris flows, erosion, and sedimentation. Historically, rapid response and immediate implementation of appropriate mitigation activities have been used to prevent or minimize damage to the pipeline from these natural processes. Contingency planning, continued surveillance, and timely mitigation would continue to be used in the future, and impacts for the proposed action would be similar to those that have previously occurred.

immediate implementation of appropriate mitigation activities. For example, installation of river control structures was required to protect the pipeline from release flows on the Tazlina River in 1997, the August 1992 flood on the Sagavanirktok River, and the very high flows on the Dietrich/Middle Fork/Koyukuk river systems in 1994 (TAPS Owners 2001a). The probability of floods along the TAPS ROW is high, and the need for maintenance or additional new works in response to a flood is high. However, because of contingency planning, continued surveillance, and timely mitigation, long-term impacts to the pipeline and the environment for the proposed action would be similar to those that have previously occurred.

In order to minimize impacts to the pipeline from flowing water, erosion, and sedimentation, the following remediation methods have been implemented (see Section 3.7.2.1):

- Adding spur dikes,
- Constructing revetments, and
- Armoring by adding riprap and gabion guidebanks.

For the proposed action alternative, the pipeline would remain subject to the impacts of flooding, debris flows, erosion, and sedimentation. The magnitude of these impacts would be independent of the throughput of oil in the pipeline. If the historical mitigation procedures and strategies continued to be followed, the long-term impacts of these processes on the pipeline would be expected to be similar to those seen historically. Short-term impacts, such as shifting the vertical support members and possibly rupturing the pipeline, might produce measurable damage, and preventive measures might be costly.

4.3.7 Groundwater Resources

Direct and indirect impacts to groundwater resources along the TAPS ROW could occur during normal operations and during postulated accidents for the proposed action. The impacts of normal operations are discussed below. Direct and indirect impacts from accidental releases are discussed in Section 4.4.4.4.

The continued presence of the pipeline and its maintenance for the next 30 years would provide impacting factors on groundwater resources along the TAPS ROW. Both direct and indirect impacts would be anticipated. Specific direct impacting factors anticipated for the proposed action include use of groundwater for TAPS activities and melting of permafrost along buried sections of the pipeline. These factors could affect the quantity, location, and quality of groundwater resources along the ROW. Indirect impacting factors for the proposed action include the first five items listed as impacting factors in Section 4.3.6.1 plus the following additional activities:

- Operating machinery to remove sand, gravel, and quarry rock from borrow sites, and
- Disposing of sanitary wastewater in septic fields at PS 6 (Fly Camp), 7, 9, 10, and 12 and discharging sanitary waste to land at PS 5 and MCCFs.

These surface activities would have no impact on the quantity of groundwater, but they could indirectly affect its quality through infiltration of contaminants. Because there are no direct releases to groundwater along the TAPS ROW and none are planned for the future for these activities, there would be no direct groundwater impacts to water quality under the proposed action.

Impacts of Proposed Action on Groundwater Resources

Under the proposed action, two processes could produce direct impacts to groundwater resources: (1) pumping water for drinking, cooking, personal hygiene, equipment washing, dust abatement, and hydrostatic testing and (2) moving warm oil through sections of the pipeline that are buried in permafrost. Because the anticipated use of groundwater would be about the same as that used historically for TAPS operations, impacts of pumping would be similar. Melting of permafrost along the ROW could change the number and size of thaw bulbs, depending on the throughput of the pipeline. However, the range of variation in the number and size of thaw bulbs is expected to remain within the historical range observed. Any changes in thaw bulbs would be local and small (less than about 60 ft in diameter).

Indirect impacts to groundwater resources could occur through infiltration of contaminated surface water. Historically, during TAPS operations, groundwater impacts from surface contamination has been local because of the presence of permafrost that limits deep percolation, the assimilation properties of the groundwater, and adherence to guidelines specified in the linewide NPDES permit. Because the activities associated with the proposed action would produce impacts similar to those observed historically, the magnitude of the impacts would also be similar. In addition, under current operations, septic fields have been used to dispose of sanitary wastewater at PS 7, 9, 10, and 12. Impacts to groundwater from these systems have been local and have not affected other groundwater users along the TAPS ROW. Continued operation of the TAPS would be expected to produce similar impacts at these septic fields.

As discussed in Section 3.8, pipeline operations have required fresh water for drinking, cooking, and personal hygiene at manned facilities; equipment washing; dust abatement on roads and workpads; and hydrostatic testing. Potable water use at pump stations has averaged about 100 gal/d per person (TAPS Owners 2001a). At the pump stations and camps, most of this water has been obtained from 25 existing wells, 6 of which are currently active (Table 3.1-1). The reported capacities of all these wells are small, ranging from 20 to 75 gal/min (Table 3.1-1). For the proposed action, groundwater use along the TAPS ROW would continue at about the same rate as has occurred historically, and regular water-quality monitoring would continue to ensure that the water meets applicable State of Alaska regulations (18 AAC 80). Because the historical impacts of groundwater use have been negligible and local, impacts of the proposed action would be expected to be similar when compared with other users along the ROW (e.g., the city of Fairbanks).

During normal operations, warm oil flows in the pipeline through regions of permafrost, transferring heat to the ground. In some areas (e.g., at PS 3), the permafrost has melted and formed thaw bulbs of groundwater (see Section 3.8). Under the proposed action, oil would continue to flow through the pipeline and maintain the presence of thaw bulbs. However, the size and number of thaw bulbs present along the ROW would depend on the throughput volume of oil and its temperature. Higher flow rates favor an increase in the number and size of the thaw bulbs; lower flow rates lead to a reduction in the size and number of thaw bulbs. Similarly, an increase in the temperature of the oil can increase the size and number of thaw bulbs. For the proposed action, the temperature of the oil is expected to be about the same as past operations, although that temperature has decreased with time as colder crude streams have been transported through the pipeline. For analysis, three levels of the oil throughput have been assumed: 0.3 million, 1.1 million, and 2.1 million bbl/d. A throughput of 0.3 million bbl/d would decrease the size and number of thaw bulbs. A throughput of 2.1 million bbl/d would increase their size and number. The historical impact of thaw bulb formation on groundwater resources has been small and local. Thaw bulbs are generally very small (up to a diameter of 60 ft [see Section 3.8]), discontinuous, and generally not usable as a source of water. Because the proposed action would not measurably alter the number, size, or degree of connection of thaw bulbs along the ROW, the impacts from permafrost warming on groundwater resources would be similar.

Many surface activities associated with the proposed action would require digging, trenching, removing surface vegetation, grading, and other ground-disturbing activities. Excavations often require the use of heavy equipment for prolonged periods and frequently require dewatering of excavations to complete all of the required tasks. These surface activities can result in contamination of surface water with soluble contaminants that can indirectly contaminate underlying groundwater by infiltration. Historical impacts from such surface activities have been local because of the presence of permafrost that limits deep percolation of the water and assimilation properties of the local groundwater. In addition, all surface releases must be within the guidelines of the linewide NPDES permit, the Wastewater General Permit, and the NPDES Permit for Storm Water Discharge from Construction Activities Associated with Industrial Activity. Because the activities associated with the proposed action would produce impacts similar to those observed historically, indirect impacts to groundwater quality are expected to be similar.

In addition to the indirect impacts from infiltration of contaminated runoff water, groundwater quality can be impacted by sanitary water from the conventional septic systems used to treat wastes at PS 6 (Fly Camp), 7, 9, 10, and 12 and by landspreading of wastewater at PS 5 and temporary MCCFs. As discussed in Section 3.8, the capacities of these septic fields are small (3,400, 1,000, 12,000, and 9,100 gal, respectively [Mikkelsen 1997]), and disposed water is in compliance with ADEC regulations. The septic fields at PS 7, 9, 10, and 12 would be nearing their typical useful life in the next 10 years and would be replaced, if necessary (TAPS Owners 2001a). Because the historical impacts of using the septic fields and of landspreading on groundwater resources have been local and have not affected any other groundwater users along the ROW, impacts of continued operation would be expected to be similar.

4.3.8 Physical Marine Environment

Potential direct and indirect impacts of the proposed action on physical marine resources are discussed in this section. The areas considered are Port Valdez, Prince William Sound, and other nearby locations that could be affected. Direct impacts are impacts that would be caused by the proposed action and occur at the same time and place. Indirect impacts would also be caused by the action, but they would occur later in time or would be located farther in distance from the action. Impacts are evaluated for 30 years of continued operation. See Section 4.4.4.5 for a discussion of potential accidental releases under the proposed action.

4.3.8.1 Discharges from the Valdez Marine Terminal

Materials discharged to the water during the continued operation of the Valdez Marine Terminal and its associated tanker operations for the next 30 years could impact physical marine resources. These discharges can be divided into the following categories: industrial wastewater, domestic sanitary wastewater, and storm water. Regulatory permits govern the type, quantity, and methods of treatment or best management practices applicable to each wastewater discharge, as discussed in Section 3.16.4.

Discharges From The Valdez Marine Terminal

Materials discharged to the water during the continued operation of the Valdez Marine Terminal and its associated tanker operations for the next 30 years could impact physical marine resources.

Impacts from Valdez Marine Terminal releases resulting from normal operations under the proposed action would not be expected to be different from historical impacts and could decrease with decreasing throughput.

Impacting factors include contaminants in the treated industrial wastewater and domestic sanitary sewage, and contaminants and sediments in overland storm-water runoff. Normal maintenance and construction activities under the proposed action could result in increased sediment loads in the Valdez Marine Terminal runoff during construction. These increases would end with the completion of the activity that could potentially cause them.

Under the proposed action, the Valdez Marine Terminal would continue to treat and release industrial wastewater, domestic sanitary wastewater, and storm water to Port Valdez. Section 4.3.12.5 provides details on the anticipated releases. Under the proposed action, effluent volumes released from the terminal to Port Valdez would be expected to remain largely unchanged, except for treated ballast water. That treated water would be expected to decrease in volume over time. Ballast and bilge waters currently account for as much as 93% of the influent to the BWTF (TAPS Owners 2001a). Reduced throughput of oil would reduce the number of tanker visits to the Valdez Marine Terminal, and segregation of ballast water in new tankers would reduce the average volume of wastewater treated on a per tanker basis (TAPS Owners 2001a).

The total BWTF effluent flow for the year 2000 was 3,785,050,000 gal or approximately 10.3 million gal/d (see Appendix C), with historical maximum monthly volumes of about 15 million gal/d. On the basis of data on existing tanker ballast water volumes, reduced future throughput, and the replacement of current tankers with tankers that have segregated ballast water, the estimated future discharges from the BWTF range from a high of 10 million gal/d to a low of 3.5 million gal/d (TAPS Owners 2001a), as shown on Figure 4.3-2. Reductions in volume would occur during the first 10 years of continued operation; after this period, volumes would stabilize.

Historically, pollutant loading of the effluent from Valdez Marine Terminal decreased over time as new treatment technologies were implemented at the BWTF. This trend should continue as a result of potential treatment changes, reduced volumes treated, and reduced loading of oily wastes from the segregated ballast water treated in the facility. Discharges are expected to continue to comply with all applicable regulations. Reduced volumes and reduced loadings would increase the residency time of the wastewater in the BWTF, resulting in slightly more degradation in the biological treatment tanks (TAPS Owners 2001a). These reduced volume and waste loadings may require adjustments to the operation of the BWTF. However, the maximum capacity and potential maximum flow rate of the BWTF are expected to remain the same (TAPS Owners 2001a).

No changes would be expected in the volumes or composition of domestic sanitary sewage or storm-water runoff as a result of the proposed action (TAPS Owners 2001a).

Normal maintenance and construction activities could result in increased sediment loads in the runoff from the Valdez Marine Terminal. These impacts could be minimized by following standard construction practices and stipulations of required construction permits. These impacts would cease with the completion of the construction activity.

Impacts from releases from normal operations at Valdez Marine Terminal under the proposed action would not be expected to be different from historical impacts and could decrease with decreasing throughput.

4.3.8.2 Trace Elements

Under the proposed action, no increase in releases of trace elements to Port Valdez or Prince William Sound would be expected from normal operations. Changes due to decreased tanker traffic and decreased volumes released from the BWTF could potentially lower the amount of trace elements released. However, discharges would continue. Impacts from trace elements resulting from normal operations under the proposed action would not be expected to be significantly different from those resulting from historical operations.

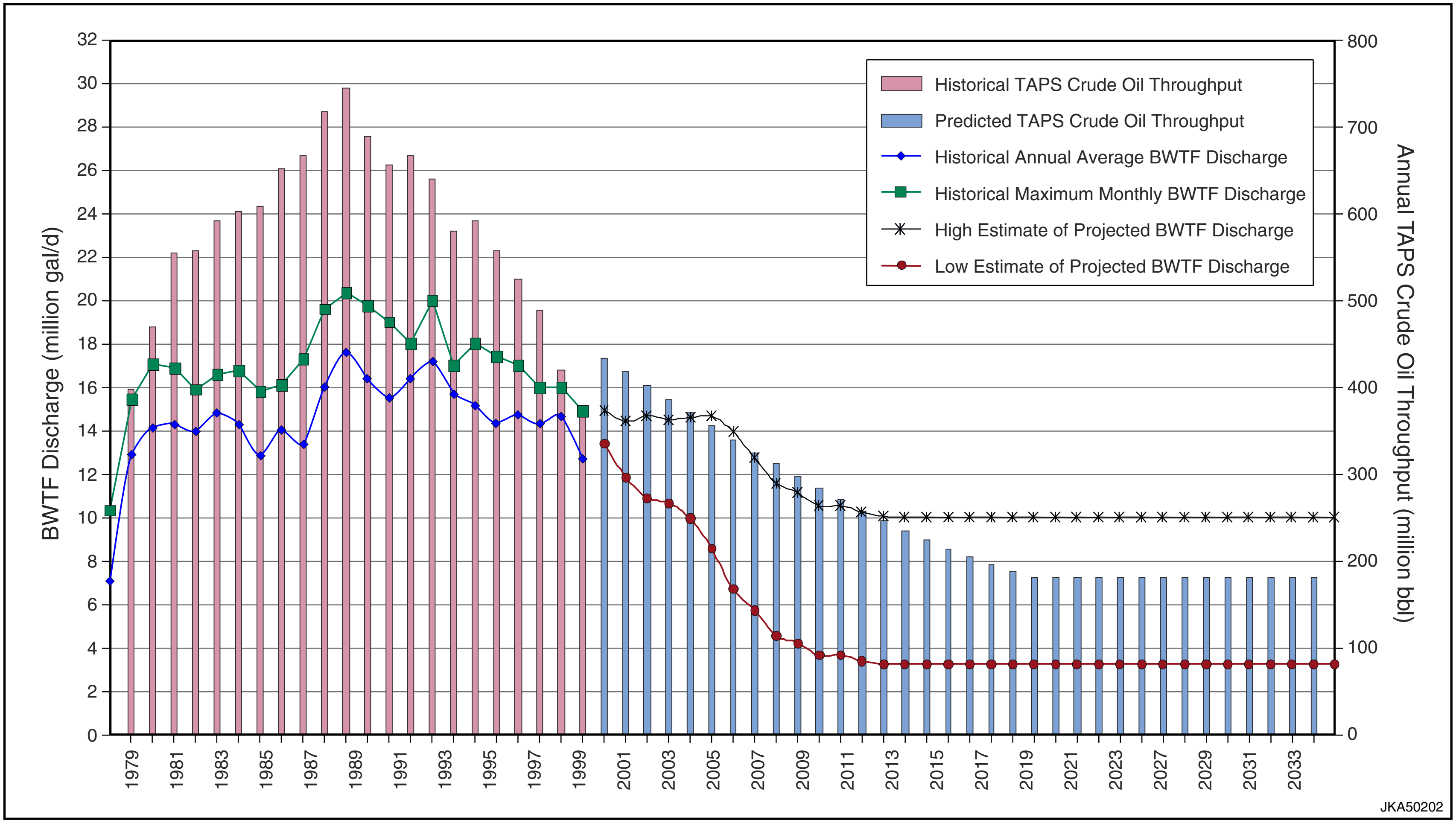

FIGURE 4.3-2 Historical and Projected Flows from the Ballast Water Treatment Facility Discharge and TAPS Throughput (Source: TAPS Owners 2001, Figure 4.3-15)

4.3.8.3 Hydrocarbons

Under the proposed action, the only hydrocarbon discharges to the physical marine environment expected from normal operations are addressed in Section 4.3.8.1, with the exception of very small releases that could accompany the normal operation of the tanker fleet and the SERVS. No increase in these discharges from historical levels would be expected under the proposed action; in fact, the potential for impacts should decrease with the reduction in throughput and tanker traffic.

4.3.8.4 TAPS-Associated Marine Transportation

Factors associated with normal tanker operations that could affect physical marine resources include small hydrocarbon emissions addressed above and the physical transit of tankers through Prince William Sound, into Port Valdez, and docking at the Valdez Marine Terminal. The berths at the Valdez Marine Terminal are in deep water, and sediment studies in Port Valdez have not noted any significant impacts to the benthic sediments from normal tanker operations (Hood et al. 1973; Gosnik 1979; Colonell 1980; Feder and Shaw 2000; TAPS Owners 2001a). Transit of the tankers through Prince William Sound under normal operations also has not resulted in any observed impacts on physical marine resources.

It is estimated (Folga et al. 2002) that the number of tanker visits to the Valdez Marine Terminal will decrease from 496 in 2004 to 82 in 2034. Accordingly, any impacts from normal tanker operations under the proposed action would decrease over the course of the proposed action.

4.3.9 Air Quality

The potential impacts on air quality and air-quality-related values (AQRVs) in the vicinity of TAPS facilities that would result from emissions associated with TAPS operation and maintenance activities under the proposed action are discussed in this section. The discussion includes estimates of emissions (criteria pollutants, hazardous air pollutants [HAPs], and CO_2) and of impacts on ambient air quality, visibility and acid deposition, the primary AQRV of interest, and on global CO_2 concentration level. The discussions focus on emissions from pump stations and the Valdez Marine Terminal facilities. Potential impacts are evaluated for three levels of TAPS operation in terms of crude oil throughput — 0.3, 1.1, and 2.1 million bbl/d. Because of the large distances separating each of the TAPS facilities,[1] emissions from one facility would have little or no air quality and AQRV impact on areas in the vicinities of other facilities. Therefore, potential air quality and AQRV impacts are discussed for specific pump stations or the Valdez Marine Terminal, as appropriate.

Potential air quality and AQRV impacts due to emissions resulting from accidental release or spills of crude oil and petroleum products during the period of TAPS operation and maintenance under the proposed action are discussed in Section 4.4.4.6.

Impacts of Proposed Action on Air Quality

The potential impacts on air quality and air-quality-related values (AQRVs) (visibility and acid deposition) from emissions associated with TAPS activities under the proposed action have been estimated. Maximum concentrations of criteria pollutants are estimated to be below applicable standards. Hazardous air pollutant emissions from TAPS are estimated to contribute little to the ambient concentrations in residential areas. Carbon dioxide emissions from TAPS would add little to the global CO_2 concentration level. Water vapor emissions from TAPS and associated facilities and activities would not contribute noticeably to ice fog problems. Analyses for specific TAPS sources did not predict any adverse visibility impacts. The impacts of TAPS facility emissions on acidic deposition would be minor.

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1 The minimum distance between two adjacent TAPS facilities is about 32 mi between PS 3 and PS 4.

The potential system upgrades under the proposed action are described in Section 4.2.2.6.3. The system upgrades that would affect emissions from existing TAPS facilities and TAPS-related activities include (1) replacement of existing fuel-gas-fired turbine pumps with more efficient units at PS 1, 3, and 4 or with electric motor-driven units at PS 7, 9, and 12 and (2) removal of all pump-station-related infrastructure at currently ramped down PS 2, 6, 8, and 10. Because of the preliminary nature of these proposed upgrades, information necessary for detailed air quality impact assessment is not yet available. However, all of these system upgrades would result in reduced long-term emissions from these emission sources and, consequently, reduced air quality impacts. Although there would be air quality impacts due to emissions released from construction-related activities associated with the upgrades, they would be local and short-term and are estimated to be small.

4.3.9.1 Criteria Pollutants

Existing emission sources at 11 pump stations (PS 1 through 10 and PS 12) and at the Valdez Marine Terminal are listed in Tables 3.13-1 and 3.13-2, respectively, and potential emissions of criteria pollutants from these facilities are listed in Tables 3.13-3. Relative significance of the emissions from TAPS facilities in comparison with emissions from other major emission sources in the vicinity of each TAPS facility is shown in Table 3.13-4. A summary of available ambient air quality monitoring data in the vicinity of TAPS facilities, modeled air quality concentration increases due to emissions from TAPS facilities, and estimated total ambient air quality concentrations that include both the TAPS facility contributions and background concentrations is presented in Table 3.13-9. Trends in ambient concentrations of selected criteria pollutants in the Prudhoe Bay area during a 14-year period are described in Table 3.13-10.

Air quality impacts of potential emissions (maximum emission levels allowed under ADEC operating permits) of TAPS facilities have been estimated through air quality modeling performed under the protocols approved by ADEC for PS 2 (APSC 1990a), PS 7 (APSC 1990b, 1991), PS 8 through 10 and PS 12 (APSC 1991), a generic pump station (APSC 1997), and Valdez Marine Terminal (Fluor and TRC 1995). All of the estimated maximum ambient concentrations (including TAPS facility contributions and background concentrations) are below applicable ambient air quality standards (as shown in Table 3.13-8). The maximum ambient concentrations are estimated to occur within very short distances from emission sources. For example, maximum ambient concentrations modeled for criteria pollutant emissions from the generic pump station are estimated to occur within a distance of about 0.4 mi or less from the central location of emission sources at the pump station.

Because the emissions from these facilities are not allowed to exceed the potential maximum emission levels specified in the ADEC operating permits under all operating conditions (Table 3.13-3), the estimated maximum ambient concentrations presented in Table 3.13-9 reflect the potential air quality impacts of TAPS facilities for the maximum capacity throughput of 2.1 million bbl/d. For 1.1 million bbl/d throughput, the levels of TAPS facility equipment operation and other activities that result in emissions would be mostly lower than the levels under the conditions of 2.1 million bbl/d throughput, although some may remain the same. Therefore, potential air quality impacts of operating TAPS facilities under the conditions of 1.1 million bbl/d throughput would be lower than or at most equal to the potential impacts estimated for the conditions of 2.1 million bbl/d throughput. Under the conditions of 0.3 million bbl/d throughput, potential impacts could be even lower.

Fuel-combustion sources at PS 1 through PS 4 are currently burning fuel gas produced in the North Slope area, although they are designed to use both liquid and gas fuels. The hydrogen sulfide (H_2S) content of the fuel gas consumed at the North Slope facilities and PS 1 through PS 4 has steadily increased from less than 10 ppm in the early years of operation to approximately 50 ppm in 2001. Even if the H_2S content of fuel gas from the North Slope area increases in the future substantially above the current levels (e.g., to 100 ppm), SO_2 emissions from burning such fuel gas would be only about one-eighteenth (5.6%) the SO_2 emissions from burning liquid fuel with a sulfur content of 0.3%, the level assumed for the calculation of SO_2 emissions from liquid fuel combustion in the air quality impact modeling performed for the generic pump station described above. Therefore, potential impacts on ambient SO_2 concentrations in the vicinity of PS 1 through PS 4 would be lower than those listed in Table 3.13-8 for the generic pump station as long as fuel gas is consumed, even if H_2S content increases substantially above the current levels.

The Fairbanks and North Pole areas are the only air quality nonattainment areas (with respect to CO) near the TAPS ROW. These CO nonattainment areas are located about 20 mi northwest of PS 8 and 33 mi south-southeast of PS 7. The estimated maximum increases in 1-hour and 8-hour average concentrations of CO from the generic pump station are estimated to be about 550 and 230 $\mu g/m^3$, respectively, corresponding to about 1 and 2% of applicable ambient air quality standards of 40,000 and 10,000 $\mu g/m^3$, respectively. Because these maximum CO concentration increases are estimated to occur within about 0.4 mi or less from the pump station, potential CO emissions from PS 8 or PS 7 would have little or no impact on the nonattainment area located more than 20 mi away from these pump stations. The ancillary TAPS maintenance and administrative facilities located within the Fairbanks nonattainment area would, under the proposed action, have continuing activities similar in scope and operation to current activities, which have little or no impact on the air quality in the nonattainment area. Therefore, no formal conformity analysis or determination is required.

> **Nonattainment Area**
>
> A nonattainment area is any area designated by EPA as not being in compliance with a specific ambient air quality standard.

As in the last 25 years of TAPS operation, continued operation of TAPS in the next 30 years would also entail certain construction activities associated with required repair and maintenance and system upgrades. Future levels of these construction activities are estimated on the basis of recent history. Over the past 5 years, excavations of mainline pipe to repair corrosion problems have averaged 14 digs per year. It is estimated this level of activity may continue or possibly increase to 20 digs per year over the next 30 years. However, it is also possible that the number of pipeline excavations may remain constant or possibly decline, depending on the performance of the new impressed-current cathodic-protection system installed along the pipeline (TAPS Owners 2001a). The principal sources of emissions associated with such construction activities would include (1) fugitive dust from land clearing and site preparation, excavation, wind erosion of exposed ground surfaces, and operation of a concrete batch plant (if needed); and (2) exhaust from and road dust raised by construction equipment; vehicles delivering materials for construction, repair, and system upgrades; and vehicles carrying construction workers. Even at the level of 20 digs per year, the sites of excavation would be scattered over the 800-mi length of TAPS ROW, and, therefore, emissions from one excavation site are not likely to have any measurable impacts on the air quality of the areas in the vicinity of other excavation sites.

The largest construction project performed since the beginning of TAPS operation was replacement of approximately 8.5 mi of TAPS main pipeline in the upper Atigun River floodplain between MP 157 and 166. Pipeline construction activities, beginning with trenching and ending with replacement of soil, lasted for about 4 months. Evaluation of potential air quality impacts conducted as a part of a comprehensive environmental impact evaluation of the project concluded that potential air quality impacts for the short-term project with all planned mitigation measures implemented would be minor, and no applicable ambient air quality standards would be violated (JMM 1990).

Construction projects anticipated during the next 30 years of TAPS operations could be larger or smaller than the Atigun Pass pipeline replacement project. Any sizable construction projects similar to the Atigun Pass project would have to be evaluated with respect to their potential environmental impacts, including air quality impacts, and mitigation measures would be required so that no significant air quality impacts would occur.

4.3.9.2 Hazardous Air Pollutants

Potential emissions of HAPs from the 11 pump stations and Valdez Marine Terminal are listed in Table 3.13-6. Common sources of HAPs at TAPS facilities include vapor releases from crude oil tanks, stack releases from combustion equipment, and equipment leaks. Crude oil tanks at PS 1 and Valdez Marine Terminal are storage tanks and those at the remainder of the pump stations are breakout tanks (Tables 3.13-1 and 3.13-2). Vapor releases from crude oil storage tanks at PS 1 are flared (burned off as they are vented), while those at Valdez Marine Terminal are collected and incinerated. Vapor releases from crude oil breakout tanks[2] at other pump stations are emitted directly into the atmosphere. In addition to these common sources, Valdez Marine Terminal has unique HAPs emission sources — the BWTF system and tankers being loaded with crude oil at berths that are not connected to the vapor collection system. As can be seen in Table 3.13-6, potential HAPs emissions from individual pump stations are less than about 9% of those from Valdez Marine Terminal. Therefore, ambient HAPs impacts due to emissions from individual pump stations are estimated to be only small fractions of those due to the emissions from Valdez Marine Terminal.

Data on ambient concentrations of six HAPs collected at four monitoring sites in the Valdez area are listed in Table 3.13-11. The data were collected for a one-year period (November 1990 through October 1991) when the TAPS average crude oil throughput was about 1.8 million bbl/d and before the installation of the tanker vapor recovery system at Valdez Marine Terminal in March 1998.

It was estimated that recovery of VOCs by the tanker vapor recovery system and subsequent destruction of collected VOCs in incinerators or power boiler furnaces would result in elimination of about 27,600 tons per year of VOCs containing the above-mentioned HAPs (Fluor and TRC 1995), about eight times the current estimate of potential VOC emissions from Valdez Marine Terminal. Furthermore, the on-going process of replacing the existing single-hulled tankers being used to transport the oil to the West Coast with double-hulled tankers is projected to be completed by the year 2013 (GAO 1999). Use of double-hulled tankers makes it possible to segregate ballast water and would reduce the average volume of ballast water per tanker. Consequently, the volume of ballast water to be treated in the BWTF at Valdez Marine Terminal would also be reduced. This treatment process is a main source of HAPs emissions at Valdez Marine Terminal. Therefore, it is estimated that current ambient HAPs concentrations in the vicinity of Valdez Marine Terminal, even under the conditions of 2.1 million bbl/d throughput, would be substantially lower than those monitored during the 1990-1991 period. Ambient HAPs concentrations are expected to continue to decrease until 2013, when the tanker conversion process is expected to be complete. Under the conditions of 1.1 or 0.3 million bbl/d, the ambient HAPs concentrations in the vicinity of Valdez Marine Terminal would be even lower.

Potential health effects due to exposures to HAPs emitted from TAPS facilities under the proposed action are discussed in Section 4.3.13.2.2. Potential impacts of accidental oil spills on ambient HAPs concentrations are discussed in Section 4.4.4.7.

4.3.9.3 Other Pollutants

Emissions of ozone-depleting substances (ODSs), which also act as greenhouse gases, released from the TAPS in recent years are

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2 A breakout tank is defined as a tank used to (1) relieve surges in a hazardous liquid pipeline system or (2) receive and store hazardous liquid transported by a pipeline for reinjection and continued transportation by pipeline (49 CFR 195.2). In this definition, hazardous liquids include petroleum, petroleum products, or anhydrous ammonia.

listed in Section 3.13.1.3. The small amounts of annual ODSs currently released from the TAPS would be further reduced gradually during the 30-year renewal period under the proposed action because the production of these substances was phased out in 2000, and they are being replaced as industry develops suitable substitutes. Thus, TAPS operations during the renewal period would contribute little to the depletion of stratospheric ozone.

Potential emissions of CO_2, a greenhouse gas, from the TAPS were estimated to be a very small fraction of global CO_2 emissions (Section 3.13.1.3). Carbon dioxide emissions from the TAPS during the 30-year renewal period under the proposed action would be smaller than the current level because less fossil fuel would be used after the potential TAPS system upgrades (Section 4.2.2.6.3) were implemented. Less fossil fuel would be used because the system upgrade would (1) replace fuel-gas-fired turbine pumps with more-fuel-efficient units at PS 1, 3, and 4 or with electric motor-driven units at PS 7, 9, and 12 and (2) remove all pump-station-related infrastructure, including fuel-burning equipment, at currently ramped-down PS 2, 6, 8, and 10. Therefore, TAPS CO_2 emissions during the renewal period would contribute little to the global CO_2 concentration level.

4.3.9.4 Visibility

Information on heavy fogs restricting visibility at the six National Weather Service stations along the TAPS ROW and on visibility impairment due to ice fog in the Fairbanks/North Pole area is presented in Section 3.12.4, and information on visual range at the Denali National Park, a PSD Class I area where visibility is an important value, is presented in Section 3.13.2.3. The following information discusses potential impacts of continued TAPS operation on these environmental factors.

4.3.9.4.1 Impacts on Ice-Fog-Prone Areas. During the winter, at ambient temperatures of –20°F or colder, water vapor emitted from equipment and vehicle operations at TAPS facilities has a potential to contribute to periodic ice fog episodes that cause serious visibility problems in areas prone to ice fog.

Among all TAPS facilities, PS 1 may have the highest potential for impacts on ice fog episodes. However, its contribution of water vapor to the North Slope area is minor by itself, as well as in comparison with emissions from most other major facilities in the area. (The contribution of water vapor emissions from PS 1 can be estimated from the emission rates of combustion-related pollutants from PS 1 and those from the area's major facilities, as provided in Table 3.13-4.)

Pump Station 8, which currently is in rampdown mode operation, also has some potential to contribute to ice fog problems in the Fairbanks/North Pole area when winds are from the southeast. PS 8 is located about 20 mi southeast of the Fairbanks/North Pole area. However, prevailing winds in the Fairbanks/North Pole area are from the north to northeast; winds from the southeast quadrant are the least frequent (Figure 3.12-3). In addition, the water vapor emitted from PS 8 would have dissipated to a negligible level by dispersion while being transported over a distance of 20 mi to the Fairbanks/North Pole area. Therefore, potential impacts of water vapor emissions from PS 8 to the ice fog problem at the Fairbanks/North Pole area are estimated to be negligible.

Pump Station 7 is located too far from the Fairbanks/North Pole area (33 mi north-northwest) to have any noticeable impacts on the ice fog problem in that area. All other stations are sufficiently distant from ice-fog-prone areas that they would not contribute noticeably to periodic ice fog episodes.

The above assessments of potential impacts of TAPS facility operations are relevant to the conditions of 2.1 million bbl/d throughput. Under the conditions of 1.1 million bbl/d throughput, such potential impacts would be even smaller, because fuel consumption, and consequently water vapor emissions, would be smaller in general at all TAPS facilities, in particular at PS 8, which would be in rampdown mode operation. Under the conditions of 0.3 million bbl/d throughput, potential impacts could be even lower still.

4.3.9.4.2 Impacts on Visibility-Sensitive Areas. Visibility impact analyses have been performed for potential impacts of (1) the emissions from PS 2 and PS 7 on visibility at Denali National Park, the PSD Class I area nearest to these pump stations (about 378 mi south of PS 2 and about 95 mi south-southwest of PS 7) (APSC 1990a,b), and (2) the emissions from the tanker vapor recovery project at Valdez Marine Terminal on visibility at Tuxedni National Wilderness Preserve, the PSD Class I area nearest to Valdez Marine Terminal (about 200 mi to the west), Wrangell-St. Elias National Park and Preserve, a sensitive Class II area nearest to Valdez Marine Terminal (about 55 mi to the east), and a second Class II area location frequented by recreational vehicle users approximately 3 mi east of the main emission sources of Valdez Marine Terminal (Fluor and TRC 1995). These analyses predicted that the emissions from these TAPS sources would not cause any adverse visibility impacts at the specified Class I and sensitive Class II areas.

4.3.9.5 Acid Deposition

Information presented in Section 3.13.2.4 on acid deposition at the two NADP acid deposition monitoring sites in Alaska (Poker Creek and Denali National Park and Preserve) indicates that acid deposition rates in Alaska are very low and have shown a trend of decreasing sulfate and no significant change in nitrate over the last 20 years.

Potential emissions of SO_2 and NO_x, the primary precursors of acidic species, from TAPS facilities are only small fractions of Alaska's total emissions (Table 3.13-4). Therefore, it is estimated that the impact of TAPS facility emissions on acidic deposition at the sensitive receptors near TAPS facilities would be minor.

4.3.10 Noise

Section 3.14 describes the existing noise sources at TAPS facilities, levels of noise generated by these sources, and ambient noise levels in adjacent areas. Although there are no noise measurement data for the areas inside facility boundary lines and in the immediate vicinity of TAPS facilities, no adverse impacts beyond facility boundary lines due to noise from existing stationary TAPS facility sources are known. Some disturbances to wildlife caused by noise from air traffic, particularly helicopters, during pipeline surveillance overflights have been reported (TAPS Owners 2001a). Additional information on such disturbances to wildlife is provided in Section 4.3.17.2.

Construction activities associated with required repair and maintenance and with future system upgrades for the TAPS under the proposed action would require use of heavy construction equipment and vehicles. They generate noise levels from about 80 to 100 dBA at 50 ft from the source, but these levels would decrease to about 70 dBA or less within 200 to 1,600 ft from the source area, which is the EPA guideline level (in L_{eq}) for protection against hearing loss over a 40-year period.

Noise Impacts of Proposed Action

Noise emitted from TAPS facility operations and maintenance activities under the proposed action is estimated to be barely distinguishable from background noise levels at the towns and residences closest to the site boundaries of each TAPS facility. Potential impacts of noise due to construction activities associated with repair and maintenance and future TAPS system upgrades required under the proposed action would be temporary and decrease to the EPA guideline level for hearing protection or less within 200 to 1,600 ft. Noise from air traffic, particularly helicopters, during pipeline surveillance overflights under the proposed action is expected to cause some disturbances to wildlife in the immediate vicinity of flight paths.

The noise impacts from TAPS construction and operational activities would not be affected very much by the TAPS crude oil throughput level; therefore, no adverse impacts would be expected during the 30-year renewal period of TAPS facility operation regardless of the level of crude oil throughput.

4.3.11 Transportation

Transportation of personnel, materials, and supplies would continue at about the current levels with renewal of the TAPS ROW for 30 more years. Currently, pipeline throughput is approximately 1 million bbl/d. Should throughput drop as low as 0.3 million bbl/d or rise again to near the maximum throughput of 2.1 million bbl/d, maintenance, surveillance, and repair operations on the pipeline itself would continue at near the same level of effort. Lower throughput might result in additional pump stations being put in standby, and higher throughput might result in existing standby pump stations being brought back online. The current transportation infrastructure, as discussed in Section 3.1.2.1, was in place to handle operational requirements at peak throughput levels (2.1 million bbl/d) and, therefore, is adequate to support continued TAPS operations at higher levels of throughput than is currently experienced.

Impacts of Proposed Action on Transportation

The current Alaskan transportation network that supports TAPS operations is an upgraded version of the infrastructure that was in place to handle maximum capacity throughput levels of 2.1 million bbl/d. Thus, the current transportation infrastructure is adequate to support pipeline activities at any anticipated throughput level.

4.3.11.1 Aviation

Aviation plays an important role in TAPS operations. Workers travel to and from PS 1, 3, 4, 5, and 12 by air for one- or two-week shifts. Routine surveillance and mapping operations are conducted from aircraft. Some parts and supplies are shipped by air. Aviation also plays a similar role in North Slope oil field operations. Such operations would be expected to continue if the Federal Grant is renewed.

4.3.11.2 Marine

Some materials and supplies for TAPS operations are received by barge from the Lower 48 States. One example is the drag reducing agent used in the pipeline. Inland waterways are not used in direct support of TAPS operations but are used to supply and maintain emergency oil spill response equipment. In addition, tankers are used to transport the TAPS oil from the Valdez Marine Terminal to refineries and other customers. In 1999, an average of 37 tankers were filled per month at the Valdez Marine Terminal when the pipeline throughput averaged 1.1 million bbl/d (APSC 2001i). This level of activity could increase or decrease with changes in oil throughput if the ROW is renewed.

4.3.11.3 Rail

Railroad transport is used for shipment of some materials and supplies. As an example, the drag reducing agent shipped by barge to Alaska is transported by rail to Fairbanks. On average, about one railcar of drag reducing agent is shipped every two months (Kramer 2001). No major change in this level of activity is anticipated.

Some crude oil from TAPS is sent to refineries in the Fairbanks area. The finished petroleum products are used locally and shipped throughout Alaska. Shipment by rail of refined products from Fairbanks to Anchorage helped petroleum shipments account for nearly one-third of the Alaska Railroad Corporation’s revenue in 1999 (ARRC 2000).

4.3.11.4 Road

TAPS operations rely heavily on Alaska’s existing roadways. Routine surveillance, maintenance, and repair of the pipeline occur continuously along the pipeline. APSC personnel logged over 11 million mi on service vehicles, excluding construction equipment, in 2001 in the performance of these functions (Norton 2001a).

The bulk of materials and supplies for the pump stations and the Valdez Marine Terminal are delivered via truck shipments. Turbine fuel is shipped approximately once a day (14,000 gal) from the refinery in Valdez to PS 12 in a tractor-trailer tanker and associated pup trailer. However, some arctic grade fuel is received by PS 12 from the refinery in North Pole during the winter months — 93,000 gal in 2001 through October 31 (Kramer 2001). Pump Stations 7 and 9 use more fuel than PS 12 and receive their turbine fuel via truck from the refinery in North Pole. For 2001, as of October 31, consumption of turbine fuel at PS 7 and 9 averaged 21,000 and 35,000 gal/d, respectively (Kramer 2001). The other operating pump stations (PS 1, 3, and 4 [PS 5 is a relief station only]) run off the natural gas fuel line from the North Slope fields.

The Dalton Highway primarily supports TAPS and North Slope operations. The average annual daily traffic on this highway in 1998, 1999, and 2000 was 261 vehicles, 213 vehicles, and 233 vehicles per day, respectively (ADTPF 2001). The level of road traffic for such activities could vary slightly in response to pipeline throughput levels under the proposed action.

4.3.12 Hazardous Materials and Waste Management

4.3.12.1 Hazardous Materials Management

4.3.12.1.1 Materials Usage. Hazardous material usage in routine TAPS operations is described in Section 3.16.1 and Appendix C. With continuation of TAPS operations, no significant changes would be anticipated with respect to either the types or the amounts of hazardous materials used or the current logistical arrangements for storage or distribution of hazardous materials throughout the TAPS facilities. A detailed description of hazardous materials used in connection with the TAPS is provided in Appendix C.

Administrative controls established within the APSC HAZCORE system would continue to play a pivotal role in controlling hazardous materials usage. Program elements such as review and approval of new hazardous materials being proposed for use, shelf-life monitoring, and material consolidation and redistribution, as well as complementary waste management programs such as recycling and reuse of spent or excess materials, can be expected to maintain the level of hazardous material usage at or near its present condition. More aggressive management practices in these programmatic areas can even be expected to result in an overall decrease in the amounts and types of hazardous materials used. Continued commercial development of nonhazardous or less hazardous alternatives to commonly used solvents and protective coatings can also be expected to result in a decrease in hazardous materials usage as such alternatives are incorporated into APSC work practices.

Most of the hazardous materials used by APSC are readily available and can be expected to remain so into the foreseeable future. One notable exception, however, is Halon 1301™ (bromotrifluoromethane), a chlorofluorocarbon that is used extensively in fire suppression systems at pump stations and at the Valdez Marine Terminal. Halon 1301, a Class I ozone-depleting chemical (ODC), is no longer being produced. Consequently, APSC must rely on its existing stocks as well as its purchase of additional Halon from secondary markets to maintain its fire suppression systems. APSC has modified the fire suppression systems to eliminate or greatly reduce the probability of accidental discharges of Halon.

As availability of Halon decreases, APSC may need to undertake a wholesale redesign of its fire suppression systems in future years and replace Halon with a different fire suppressant that is currently available. It can be reasonably anticipated, however, that there will continue to be a secondary market for any Halon removed from redesigned systems, such that no significant amount of waste Halon is anticipated in association with this transition.

Hazardous Materials Usage and Management under the Proposed Action

Hazardous material usage and management under the proposed action would be similar to current circumstances. The majority of hazardous materials used would continue to be refined petroleum products that serve as fuels for TAPS equipment and vehicles, including aircraft. Waste generation and management under the proposed action would be fundamentally the same as current activities. Hazardous waste would be delivered to out-of-state facilities for treatment and/or disposal. Solid wastes would be managed in APSC-owned or municipal landfills; however, some would be incinerated at pump stations prior to landfill disposal. Industrial wastewaters generated along the ROW (e.g., excavation dewatering) would be managed according to the current linewide NPDES permit. Industrial wastewaters at the Valdez Marine Terminal would continue to be treated in the BWTF and discharged to the Port of Valdez under the authority of the current Valdez Marine Terminal NPDES permit. Domestic and sanitary wastewaters generated at pump stations and at the Valdez Marine Terminal would continue to be managed by stack injection, septic systems, activated biological treatment package plants, or through treatment agreements with nearby municipalities. Minimal amounts of special wastes (e.g., PCBs, asbestos, medical waste, etc.) are expected to be generated and would continue to be managed in accordance with existing procedures and regulations.

It is assumed that any alternative material selected by APSC would conform to the Significant New Alternative Policy published by the EPA.[3] However, numerous circumstantial factors need to be considered before completely acceptable substitutes can be selected for each APSC installation that currently relies on Halon. Such factors include the engineering logistics and limitations of modifying or replacing existing systems to accommodate any new fire suppressant, overall effectiveness of the agent in each application being modified, worker safety, and cost.

Ozone-Depleting Chemicals

Chemicals designated by the EPA as Class I ODCs have the greatest potential to deplete ozone present in the earth's stratosphere. Class I ODCs display ozone-depleting potentials (ODPs), ranging from a high of 10 to a low of 0.02 (a dimensionless value). Halon 1301 has an ODP of 10 (see 40 CFR Part 82, Subpart A, Appendix A). In accordance with the Montreal Protocol, the Clean Air Act Amendments of 1990, and federal regulations, production of Class I ODCs ceased on January 1, 2002. However, the continued use of Halon is still authorized (see Clean Air Act Amendments § 604 and 40 CFR Part 82).

4.3.12.1.2 Impacts of Hazardous Materials Usage. With respect to hazardous materials usage, both direct and indirect impacts can be identified. Direct impacts result from those activities that involve the use of hazardous materials in direct support of pipeline operations (e.g., the use of a heat transfer fluid in a turbine pump or the use of Halon in fire suppression systems). Both APSC employees and contractors conduct such activities.

Indirect impacts result from the use of hazardous materials in essential or ancillary activities (e.g., use of glycol-based antifreeze in both on- and off-road vehicles or aviation fuel for helicopters used in aerial inspections). Contractors conduct many such activities. However, because all hazardous materials usage associated with such activities is centrally controlled, the available operating record as described in Section 3.16.1 and Appendix C indicates the collective impacts of all hazardous material usage in both direct and indirect activities by both APSC employees and operation and maintenance (O&M) contractors.

Some additional contractor activities that involve hazardous material usage are also known to be occurring. Such activities are

3 In 40 CFR Part 82, Subpart G, the EPA has identified substitutes for ODCs that will present less hazards to human health and the environment than the ozone-depleting compound(s) they replace. The EPA has already identified eight commercially available substitutes for Halon in a total flooding agent fire suppression application, such as those existing in TAPS facilities (40 CFR Part 82, Subpart G, Appendix A).

outside of APSC administrative controls and would result in additional indirect impacts. For example, commercial entities provide transportation and distribution of supplies and fuels. Hazardous materials used to maintain those commercial vehicles and vessels, as well as their fuel consumption, qualify as indirect impacts.

Numerous other services are provided by contractors or commercial businesses on periodic or as-needed schedules. Because such services invariably involve specialized knowledge and equipment or are needed only infrequently, such support services would likely continue to be provided by external resources. These services include such wide ranging activities as servicing of office machines and major infrastructure systems (e.g., building HVAC systems), conducting ecosystem studies, installing and servicing special technologies (e.g., communication and control systems), and conducting special engineering studies and services (e.g., removal and remediation projects involving asbestos-containing building components). Some specialized equipment fabrication, repair, and replacement services also are provided.

The amounts of hazardous materials used by private contractors engaged in such activities are expected to be relatively small, and no effort has been made to quantify the materials used or subsequent impacts. (However, air quality impacts from fuel consumption related to contractor activities are addressed in the air emission impact evaluation [Section 4.3.9].) Hazardous material usage by external resources in support of continued TAPS operations is not expected to undergo substantial change.

4.3.12.2 Waste Management

The operating record described in Chapter 3 with respect to waste generation and management is expected to be generally representative of waste impacts from continued TAPS operations into the foreseeable future (Section 3.16.2). However, anticipated changes in management philosophy and oil throughputs may cause subtle but identifiable changes in the generation and subsequent management of wastes.

The major factors that may influence the nature and amounts of future wastes and the manner in which they are managed are discussed below. It is also probable that regulations governing waste management would evolve to the extent that existing management strategies would no longer be appropriate, adequate, or cost effective. However, it is assumed that APSC would adjust its waste management activities to maintain compliance with evolving regulatory requirements and that there would be no environmental impacts from such changes beyond those anticipated by the modified regulations and standards.

4.3.12.2.1 Waste Impacts Resulting from Changes to Management Strategies and Oversight Postures. The JPO and APSC are currently engaged in discussions regarding the adoption of an RCM approach to asset maintenance. Under such a scenario, each critical piece of pipeline equipment and the pipeline itself would be evaluated for the role it plays in system operation. In an RCM approach, both environmental impacts and safety factors would be considered in determining the consequences of equipment failure and assigning priority to certain maintenance tasks. The impacts of operational disruption would also have a role in setting priorities. Notwithstanding responses to accidental releases and major equipment repairs or replacements, routine and preventative maintenance activities are currently the major sources of waste. Changes to maintenance priorities may, therefore, impact future waste generation rates.

Because strategic decisions regarding an RCM approach are still evolving, the impacts of such a maintenance strategy can only be qualitatively identified at this time. It is possible that certain pieces of equipment would have a higher priority placed on their maintenance than is now the case because of the calculated consequence of their failure. In such a case, “consequence” may include disruption to TAPS operations (i.e., the continuous delivery of oil to Valdez Marine Terminal and beyond) as well as impacts to the environment as a result of loss of TAPS system integrity (i.e., an accidental release) or impacts to the safety of workers or the public. This higher priority may in some instances dictate that maintenance actions occur on a more frequent basis than is currently the case. However, the maintenance action itself is not likely to change.

Conversely, some maintenance intervals may be increased with no anticipated loss in performance reliability or increase in failure probability. Thus, with respect to waste generation, the character of maintenance-related waste is not likely to change with the adoption of an RCM-based maintenance strategy, although the overall volumes of individual maintenance-related waste streams may vary as RCM protocols are applied to individual TAPS elements or systems. Such volumetric changes are expected to be relatively minor, however, and are not likely to unduly impact the capacities of the existing waste management systems.

4.3.12.2.2 Impacts Resulting from Changes to TAPS Operational Conditions. In addition to changes to management philosophies that would impact maintenance postures, changes in operating conditions might also have significant impacts on the character and volume of waste generated. The most dramatic changes would result from changes in the status of major facilities, such as the ramping down of currently active pump stations or the restarting of currently inactive facilities (such as pump stations now on standby or "mothballed" topping plants). While changes to waste generation and management can be anticipated from such events, there are no published schedules for the reactivation of any currently dormant facility. However, rampdowns of some facilities can be reasonably anticipated (see Section 4.2.2.6.3 for a discussion of planned upgrades and modifications). Projected reductions in crude oil throughput may allow for the rampdown of additional pump stations. Discussions in the following sections, therefore, include an analysis of the impacts to waste management from any such changes to facility status. The categories of wastes analyzed are the same as those used to describe TAPS waste profiles in Section 3.16.

4.3.12.2.3 Direct versus Indirect Impacts from Waste Generation and Management. It is possible to differentiate wastes directly related to TAPS operations from those with a more indirect relationship. As was the case for hazardous material usage, it is possible to distinguish individual waste streams as representing either direct or indirect impacts, depending on the nature of the activities from which the waste originates. However, waste management is centrally controlled wherever possible, including the commingling of wastes equally eligible for the same management scheme, regardless of the sources of the wastes. Consequently, distinguishing between waste stream origins and determining whether each waste stream should be considered a direct or indirect impact adds little benefit to an overall understanding of the collective environmental impacts from TAPS wastes.

4.3.12.3 Hazardous Wastes

Routine and preventative maintenance activities will continue to result in generation of hazardous waste along the pipeline and at the Valdez Marine Terminal. Preventative maintenance waste generation is cyclical and therefore may be impacted by the adoption of RCM strategies, although the chemical composition of the wastes is not expected to dramatically change. Generation of maintenance-related wastes may also increase as critical equipment nears the end of its useful life and undergoes major refurbishment or replacement.

Section 3.16.2 and Appendix C provide descriptions of the hazardous wastes representative of past routine TAPS operations. Table C-2 provides types and quantities of hazardous waste generated from January 1998 through December 1999. Notwithstanding the influence of RCM strategies, these data are considered to also be representative of the nature and amounts of hazardous waste that can reasonably be anticipated into the foreseeable future from continued pipeline and Valdez Marine Terminal operations. This conclusion is valid only if there are no major reconfigurations of the TAPS (e.g., rampdowns or new or reactivated facilities) or substantial changes to the quality of the crude oil (i.e., its chemical composition, because that affects the chemical constituency of maintenance-related wastes) being delivered through the pipeline. Further, the hazardous waste management procedures described in Section 3.16 are also expected to undergo very little change.

The rates of hazardous waste generation have been nominally low during periods of routine TAPS operations, thereby allowing most locations at which hazardous waste generation occurs to maintain eligibility for "Conditionally Exempt Small Quantity Generator" status. This situation is expected to continue to be the case during routine operations.

Conditionally Exempt Small Waste Generators

Under federal hazardous waste regulations, various categories of waste generators are defined. A conditionally exempt small quantity generator is one who generates less than 100 kg (220 lb) per month (at each noncontiguous facility operated). Conditionally exempt small quantity generators enjoy exemption from many of the requirements imposed on large quantity generators. These exemptions are outlined in 40 CFR 261.5.

Tank bottoms, sludge, and sediment continuously accumulate in various equipment and locations within the TAPS over time. Such "materials in process" are allowed to remain within the system until their presence affects system performance; then the equipment is cleaned and such materials in process are removed and declared waste. Replacement of aging equipment may also result in the generation of some material in process.

Material in process wastes have exhibited hazardous waste characteristics in the past. Therefore, cleanout of crude oil storage tanks, facility sumps, and equipment and some equipment replacement activities would likely also exhibit hazardous waste characteristics. Changes to the crude oil stream characteristics and temperature, as well as changes to throughput, may affect the rates at which sediments accumulate in equipment, and thus the volumes of in-process wastes produced. Such wholesale cleanout activities are considered to be routine maintenance (i.e., occurring cyclically). However, in the past, the intervals between some wholesale cleanout operations have been as long as 20 years.

Waste is also generated during some repair activities. These wastes can be generated along the ROW as a result of repairs that must, by necessity, be made in situ, but would occur under controlled conditions at pump stations and maintenance facilities whenever possible. (Under current practices, contractors immediately move wastes that are generated at ROW locations to a storage facility at the nearest pump station or maintenance facility until final disposition.) Repair-related wastes might include spent solvents, sludge, and debris (including scale and rust in some instances) removed from the failed piece of equipment during its repair.

Wastes would also result from surface preparation activities for purposes of corrosion control. However, spent sandblast media and debris from the removal of original coatings have not exhibited hazardous waste characteristics in the past and have been managed as industrial solid waste. However, excess materials and wastes associated with surface preparation and the application of the new paint or coating may exhibit hazardous waste characteristics.

The character of corrosion-control-related waste is most strongly influenced by the nature of the original coatings being removed and the substitute coatings being applied. With few exceptions, the paints and coatings originally used in the TAPS have no hazardous components, and their eventual removal would not result in the generation of hazardous waste. Likewise, applications of substitute coatings that are nonhazardous once they are fully cured are also not expected to result in hazardous waste generation. However, piping at the Valdez Marine Terminal used to deliver ballast water to the BWTF is known to have a lead-based paint coating underneath a rosin liner on the interior of the piping. Much of the liner and paint coating have been removed in recent years as a result of maintenance activities on the piping. If future maintenance activities require removal of the liner, it would be managed as a hazardous waste.

For the purpose of this discussion, repair-related waste does not include contaminated environmental media resulting from a release of crude oil, refined petroleum product, or hazardous material. Such “spill debris” are discussed separately below in Section 4.3.12.6. Also, any repair action that can impact system integrity would also involve performance of a hydrostatic test of the affected equipment before service is resumed. Wastewaters from such tests are discussed in Section 4.3.12.5.

Finally, lower crude oil throughputs in future years might allow for the rampdown of additional pump stations. While the long-term result of such rampdowns would be the elimination of hazardous waste from those locations, in the short-term, hazardous waste generation may increase from the cleanout of retired equipment. Such increases would be attributed to the removal of material in process (e.g., accumulated sludge, residue, tank bottoms, and condensate) that would necessarily be part of placing individual pieces of equipment into stable standby modes. Such sludge and residue may exhibit hazardous waste characteristics. The use of petroleum fuels or organic solvents in the purging of crude oil from pumps, transfer lines, surge tanks, and storage tanks; the subsequent cleaning of such equipment; and the removal of various filters might also contribute to hazardous waste related directly to rampdown actions. However, judicious choices of purging solvents might allow those organic rinsing agents to be reintroduced into the crude oil stream.

Some heat transfer fluids and coolants currently in service may also become hazardous waste if they are removed as part of a rampdown action. However, recycling might also be possible for some coolants, especially if their essential cooling properties had not yet been depleted. Such “spikes” in hazardous waste generation associated with facility rampdowns are expected to last only a matter of weeks. APSC may have to modify the physical features and administrative controls of their waste storage facilities at these locations to comply with requirements for longer-term hazardous waste storage areas or arrange for special waste pickups immediately after the rampdown-related wastes are generated.

4.3.12.4 Solid Wastes

Nonhazardous solid waste from pipeline and Valdez Marine Terminal operations falls into one of three categories: industrial solid waste, office waste, and domestic solid waste. Industrial solid waste can be identified as being either a direct or indirect impact from TAPS operations, depending on the specific activity that generated the waste. Office wastes and domestic solid wastes are considered to be indirect impacts from TAPS operations. Only marginal changes to the characteristics of these three categories of solid waste are anticipated under the proposed action. However, some volumetric changes can be anticipated. Specifically, domestic solid waste from the O&M of personnel living quarters has the potential to undergo substantial volume reduction. The volume of domestic solid waste is directly and primarily a function of the complement of personnel working and living at each TAPS facility.[4]

With steady or decreasing oil throughputs over time, less energy would be required to deliver the oil to the Valdez Marine Terminal. Consequently, additional pump stations might be put into standby mode in future years, resulting in eventual reductions in the workforce and proportional reductions in solid waste volumes at affected locations over the long term. Over the shorter term, however, volumes of domestic solid waste might increase, reflecting the increased number of workers at the facility to perform rampdown actions. Once rampdowns were completed, these volumes would decrease dramatically, reflecting the presence of only a minimal caretaker workforce (including security personnel). Industrial solid wastes would also be affected by rampdowns, with volumes increasing initially because of wastes generated directly from rampdown actions, then reducing eventually to near zero at such facilities once rampdown actions are completed. However, as

4 Currently, personnel from PS 1 reside in Deadhorse, Alaska, in facilities owned by BP and ARCO. Also, pipeline maintenance crews and emergency response personnel are quartered at various pump stations proximate to their respective geographic areas of responsibilities. It is assumed that both of these housing circumstances would continue into the period covered by a Federal Grant renewal. However, there may be some redeployment of personnel if planned pump station upgrades are pursued. (See Section 4.2.2.6.3.)

noted in Section 4.3.12.3, the majority of waste generated from rampdown actions might, in fact, display hazardous waste characteristics.

Three primary options are currently employed for solid waste management: (1) incineration of domestic and nonhazardous industrial solid wastes at PS 1, 2, 3, 4, 5, 7, 10, and 12 and at the Valdez Marine Terminal and disposal of the resulting ash in APSC or public landfills; (2) direct burial of solid waste in APSC landfills and landfills operated by various municipalities or boroughs; and, (3) recycling or energy recovery. All three options are expected to remain generally available.[5] However, some changes to current solid waste management options can be anticipated.

Amounts of solid wastes typically recycled throughout the TAPS are listed in Table C-4. However, with the exception of scrap metal, recycling markets are not reliable or economically available for all portions of TAPS where recyclable wastes are generated (Seward 2001f). ADEC officials confirm that logistical factors, especially transportation, often impede aggressive solid waste recycling in some parts of Alaska. Nevertheless, although ADEC regulations do not mandate a certain level of recycling, applicants for solid waste disposal permits (i.e., landfills) are required to demonstrate that they have considered recycling as an option to disposal of the solid wastes they receive and have made a commitment to implement recycling whenever market conditions are appropriate (Stockard 2001a).

In addition, APSC has made a corporate commitment to pursue recycling whenever feasible. Because of the scale at which it operates, APSC can often singularly create its own market for recycled materials. Transportation costs may, however, be rate-limiting factors to efficient pursuit of some recycling options. Were any of the current recycling options to disappear or become no longer economically viable, all materials would be diverted to appropriate waste disposal facilities with only nominal impacts. Finally, regardless of whether recycling remains possible, it may still be appropriate for APSC to maintain its solid waste segregation programs for wastes going to its incinerators, to guarantee the continued nonhazardous character of the resulting ash.

APSC incinerators have played a pivotal role in solid waste management by providing for substantial volume reductions to waste requiring disposal. As has been the case for previously ramped-down pump stations, incinerators at additional PS that are ramped down would likely be shut down, despite the fact that operation of the incinerators is largely independent of operation of the remainder of the pump station. At the same time, however, the incinerators have been used to treat only locally generated solid wastes.[6] Because the volumes of solid wastes at closed pump stations dramatically decrease, the loss of the incinerator has only marginal impact, and any remaining waste volumes from such facilities would be transported to the closest operational facility.

Landfilling of solid waste or incineration of solid wastes at PS 1, 3, and 4 and at the Valdez Marine Terminal followed by landfilling of ash would continue to be the main options for solid waste management into the foreseeable future (assuming no further pump station closures). Table C-3 provides data on the amounts of solid waste or ash delivered to various landfills in calendar year (CY) 2000. Historically, APSC has not been a major contributor to solid wastes going to municipal landfills; thus, any changes to TAPS solid waste generation rates are not likely to cause capacity problems at the landfills to which these wastes are being sent. Table 4.3-2 shows the amounts of APSC solid wastes delivered to each publicly owned landfill relative to the total amounts of solid wastes received at each site. Disposal of APSC ash either in its own

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5 Although they are not operated, incinerators at PS 2, 6, 7, and 10 still exist.

6 There are two exceptions: (1) the PS 7 incinerator burns oily waste from APSC operations in Fairbanks, and (2) the PS 5 incinerator also burns solid domestic and nonhazardous industrial solid wastes from PS 6.

TABLE 4.3-2 Annual Volumes of APSC Waste and Total Volumes of All Wastes Received at Publicly Owned Landfills[a]

Disposal Site	Permit Expiration	APSC Waste Received (tons /yd^3)[b]	Total Waste Received (tons/yd^3)[c,d]	Percentage of APSC Waste to Total Received (%)
Oxbow Landfill[e]	04/30/02	883.6 / 2,209	48,000 / 120,000	1.8
Anchorage Regional Landfill	08/22/06	352 / 880[f]	348,806 / 872,015	0.1
South Cushman Landfill (Fairbanks North Star Borough)	08/01/06	643.2 / 1,608[g]	91,095 / 227,738	0.7
Delta Landfill	04/30/03	NA[h]	1,500 / 3,750	NA
Glennallen Landfill (Copper Basin Sanitation)	12/31/01[i]	780 / 1,950[j]	3,480 / 8,700	22.4
Valdez City Landfill	08/21/06	580 / 1,450	4,100 / 10,250	14.1
Valdez construction debris landfill	03/31/01[k]	16 / 40	850 / 2,125	1.9
Palmer Landfill (Mat-Su Central)	11/20/05	0 / 0[l]	46,533 / 116,333 221 / 553[m]	0

[a] Data are for CY 2000 unless otherwise noted.

[b] Data provided to APSC by landfill operators (Seward 2001c-f; 2002).

[c] Data provided by ADEC in tons (Stockard 2001a) for planning and design purposes. ADEC considers 1 ton of uncompacted solid waste to compose 2.5 yd^3 (Stockard 2001c).

[d] Except for Anchorage Regional Landfill and Palmer Landfill, all values are estimates.

[e] Customers of the Oxbow landfill include APSC and all North Slope oil exploration/production companies, only.

[f] The reporting period is November 12, 2000, through November 12, 2001. Some portion of solid waste from the Bragaw facility is compacted on-site before delivery to the landfill.

[g] Totals represent wastes from Doyon industrial facility, Nordale maintenance yard, and Van Horn maintenance yard.

[h] NA = data not available.

[i] A permit application has been received by ADEC before the permit's expiration date and is currently in process. ADEC anticipates that a new permit will be issued in the summer of 2002. In the interim, the landfill has been authorized to continue operations in a manner consistent with the just-expired permit (Stockard 2002).

[j] Figures represent wastes from PS 11 and 12, as well as wastes from main-line refrigeration projects occurring over the reporting period.

[k] A permit renewal application is currently being prepared (as of November 21, 2001) (Stockard 2001b).

[l] No APSC waste was delivered to the Palmer Landfill in CY 2000 (Seward 2002).

[m] Amount of asbestos waste received from all sources. Asbestos waste totals are not included in volumes of all wastes received.

or in publicly owned landfills would remain a viable option provided APSC maintains controls for segregation of wastes going to its incinerators to ensure that the nonhazardous resulting ash remains nonhazardous.

All of the municipal landfills currently being used are likely to meet their design limits, and each landfill will see its current operating permit expire before the expiration of the proposed 30-year Federal Grant renewal (see Table 4.3-2). With the exception of the Oxbow Landfill, these disposal facilities provide the primary opportunity for disposal of solid wastes for their respective communities. Consequently, it is reasonable to assume that the municipalities or boroughs will take prudent and timely actions to extend their permits or establish new, permitted solid waste disposal facilities before design or permit limits are reached.

The Oxbow landfill exists exclusively for the use of the TAPS and the oil exploration and production companies currently on the North Slope. Although no Alaska Native communities on the North Slope use the Oxbow Landfill, it is nevertheless incumbent on the North Slope Borough authorities to maintain their permit to preserve this revenue source and to continue to provide disposal opportunities for North Slope oil companies and the TAPS. Currently, APSC delivers only incinerator ash and inert solid waste from PS 1 to the Oxbow Landfill. Historically, the amounts have not been excessive. No evidence suggests that the Oxbow Landfill will discontinue service in the foreseeable future. However, if that were to happen, APSC would have the option of redirecting those wastes to its own landfills (within the limits of their operating permits) or to the nearest municipal landfill.

The permits for all three APSC-operated landfills will expire in July 2006 (Seward 2001a,b). APSC will need to extend current permits or identify suitable new locations and pursue the necessary permits. Some difficulty may be encountered in finding a location with suitable soil conditions in an area proximate to the northernmost of the APSC landfills. It is assumed that any permit extension or permits for new locations would have limitations similar to the current permits. Therefore, APSC would be able to use any new landfills only for the disposal of nonhazardous incinerator ash or inert, nonhazardous, and nonputrescible solid waste. It is assumed that APSC would continue to use its solid waste incinerators.

With the exception of the North Slope Borough where local ordinance guarantees a revenue source by requiring all wastes generated within a prescribed service area to be disposed of in the Oxbow Landfill, there are no jurisdictional limits on solid waste disposal in Alaska (Mach 2001). Consequently, APSC would have the option, if necessary, of delivering its solid wastes to landfills located anywhere in the state if the landfills currently in use become unavailable. Notwithstanding substantial increases in transportation costs, such modified solid waste management strategies would not create additional environmental impacts over the current arrangements, assuming all of the landfills being utilized are in compliance with their respective operating permit conditions.

Under routine operations, the complement of APSC employees responsible for pipeline and pump station maintenance can be expected to remain constant or decrease slightly as more remote control technologies are introduced into the TAPS. These individuals normally reside at various pump stations or adjoining work camps, and their impact on solid waste generation is already accounted for in the above discussions. However, in the event that it becomes necessary to undertake a major pipeline repair or reroute, it can be expected that more personnel would be required to reside near the work site. Such major repair or reroute actions would undoubtedly increase the populations of workers at the nearest pump stations and camps to their respective maximum capacities, and might even result in the temporary construction of additional work camps.

The MCCF at PS 3 is an example of an existing work camp that would be used for additional worker residences. Additional solid wastes from such facilities can be expected to be nonhazardous domestic garbage and would likely be managed by the existing management schemes. However, additional provisions might be required for solid waste collection from temporary camps or from existing camps or pump stations where populations have greatly increased.

New disposal options might be necessary if the increased volumes of solid waste exceed the capacities of existing facilities (including the APSC incinerators and landfills). However, given the relatively short duration of any such worker population increases, it is not likely that additional solid waste incineration facilities would be added. Also unlikely is the establishment of an additional APSC landfill. Existing permits suggest that APSC landfills would be available to support disposal of increased volumes of solid wastes, but, ideally, that waste should first be incinerated to accommodate the limited capacities of the landfills and the permit limitations to daily volumes of wastes received. Alternative arrangements might involve transport of solid wastes to existing municipal and borough landfills. Only nominal impacts would occur at each of the landfills involved.

In addition to major reroute or repair actions, similar impacts to resident populations at some facilities might result from response to and remediation of major accidental releases of crude oil or refined product. The principal wastes from such events are contaminated environmental media (primarily soils) and miscellaneous response-related debris, all collectively referred to as remediation waste. Management of remediation waste is discussed in Section 4.3.12.6. In addition, however, major spill response actions would also affect the number of workers at living quarters near the spill site, or might even require the establishment of short-term work camps at or near the spill location. Increased numbers of workers would, in turn, increase the volumes of domestic wastes generated. Because responses to spills would be of relatively short duration (at least that portion of the response that would require substantial increases in personnel), it is anticipated that existing solid waste management options can be used to handle the short-term increases in domestic solid wastes.

4.3.12.5 Wastewater

Wastewater anticipated from continued operations and maintenance of the pipeline and the Valdez Marine Terminal would be in the following categories: industrial wastewater, domestic sanitary wastewater, and storm water. As discussed in Section 3.16.4 and Appendix C, regulatory permits govern the type, quantity, and method of treatment or best management practices applicable to each wastewater discharge.

The Valdez Marine Terminal, specifically the BWTF, is expected to continue to be the single largest source of industrial wastewater. Table C-5 shows the currently permitted influent sources to the BWTF and their respective estimated average volumes. Wastewater at the Valdez Marine Terminal can be expected to remain largely unchanged except for ballast waters. Ballast water and bilge water from tankers berthed at the Valdez Marine Terminal account for up to 93% of the flow into the BWTF (TAPS Owners 2001a). Treatment of ballast water from tankers, as well as anticipated changes to those activities because of tanker reconfiguration, are identified as cumulative impacts because such wastewaters originate from outside the TAPS system. Impacts are therefore discussed in Section 4.7.

Industrial wastewater generated in connection with O&M along the pipeline results primarily from excavation dewatering, hydrostatic testing, and secondary containment drainage. Under the proposed action, these linewide industrial wastewater discharges are expected to remain near current levels (see Table C-7).

Excavation dewatering results from corrosion control activities on sections of buried pipeline, as well as from special projects (e.g., vaulting of check valves, repairs, or replacement). Dewatering can be expected to occur anywhere along the ROW where the pipeline is buried. Corrosion control activities are considered to be preventative rather than routine maintenance and, as such, would occur only on an “as-needed” or “as-indicated” basis by routine inspections or monitoring.

Because neither preestablished schedules nor predesignated locations exist for these activities, it is impossible to predict the volumes of excavation water that would be generated in future years. Factors affecting volumes of excavation water to be managed include the location, the time of year in which the excavation takes place, precipitation events during excavation, height of the groundwater table relative to excavation depth, and topographical factors that affect surface water run-in. It is assumed that all available steps would be taken to minimize excavation water, not only to avoid the management and disposal costs, but also to prevent such water from impacting the maintenance or repair activity itself. However, when excavations are required for an emergency repair operation, such considerations may be preempted.

Historical discharges under the linewide NPDES permit are shown in Table C-7. It is assumed that these discharges are representative of discharges in future years of operation. As discussed above, under RCM, certain pieces of equipment might be assigned a higher priority, resulting in an increase in the frequency of maintenance activities. If these higher-priority elements are located underground, the volume of excavation dewatering discharges might increase somewhat in the future.

Hydrostatic testing is required whenever maintenance, repair, or replacement actions result in wholesale or partial disassembly of those portions of the TAPS in which crude oil is present. Because hydrostatic testing is normally required on the reassembled system, most test waters are generated at the project site. Historical discharges of hydrostatic testing wastewater under the linewide NPDES permit are shown in Table C-7. It is assumed that these discharges are representative of discharges in future years of operation. However, RCM-based protocols might dictate more frequent maintenance schedules, with a subsequent increase in the volume of hydrostatic test waters generated. In addition, a drop in the quality of the crude oil being recovered from aging fields could be expected to cause an increase in the volumes of wastes (sediments and sludge) accumulating in the system. This increase in waste volumes could result in increased frequencies of cleanout or maintenance activities, which would often be followed by hydrostatic testing and, consequently, an increase hydrostatic wastewater discharges.

The volumes of domestic sanitary wastewaters generated along the pipeline depend on the workforce population. A drop in crude oil throughput may allow for the rampdown of additional pump stations, with concomitant reductions of personnel at those locations. Technological enhancements may also allow for the remote operation of some pump stations, which would result in a reduction of the workforce at those locations to minimal caretaker and security forces. All such reductions in personnel would result in proportional reductions in sanitary wastewater volumes. However, major pipeline repairs or reroutes or seasonal maintenance schedules might result in temporary increases in the workforce housed at nearby pump stations or work camps (including new work camps erected exclusively to support specific major actions). These increases might cause sanitary wastewater volumes to exceed the peak capacities of the existing treatment systems at those facilities.

Although it is reasonable to assume that existing housing quarters would be used in preference to the establishment of new or short-term work camps, when such new living quarters are deemed essential, necessary provisions would also need to be established for sanitary wastewater management. Self-contained package plants for sewage capture and treatment are the most cost-effective options for such short-term needs. However, seasonal conditions may make use of such plants inappropriate, and it may be necessary to simply capture the sewage and transport it to the nearest permanently established treatment facility. Special treatment agreements between APSC and the nearest municipality may also make municipal sewage treatment plants available for such short-term treatment. Agreements of this sort have already been used to effectively deal with short-term operational problems of the sewage treatment systems at some pump stations.

Sanitary wastewater is currently treated through stack injection systems at PS 1, 3, and 4. This treatment methodology takes advantage of the waste heat in main-line oil pump turbine exhausts to destroy pathogens and vaporize filtered sanitary wastewater. However, variability in the oil throughput projected through 2010 and the resulting variability in the operating parameters of the main-line pumps have created reliability problems (Kinney and Ramos 2001). Further, a conceptual study conducted in August 2001 (Kaercher 2001) identifies the lack of a completely dedicated air line for delivery of wastewater to the exhaust stack at the appropriate pressures to ensure atomization (and thus proper destruction of contaminants) and the lack of a dual nozzle configuration in the PS 3 system as contributing factors to decreased system reliability. These variability factors have resulted in periods of operation when turbine exhaust gas temperatures and compressed air pressures in the wastewater delivery system have not met minimum requirements specified in the turbine air permits, thus requiring the temporary suspension of sanitary wastewater injection/treatment.

No serious problems are expected with the reliability or adequacy of the PS 1 stack injection system as long as operating personnel continue to reside at BP and ARCO housing facilities rather than at the facility (thus resulting in low volumes of sanitary wastewater in need of treatment). However, interruptions to stack injection at PS 3 and 4 have resulted in exceedances of the on-site storage and surge capacities of wastewater handling systems. When stack injection is unavailable at PS 3, wastewater can be delivered to the package mechanical treatment system that serves the colocated MCCF. At PS 4, untreated sewage can be diverted to an outdoor holding tank to bridge those periods of stack injection unavailability. When on-site wastewater disposal is not available, sewage must be hauled to the North Slope Borough wastewater treatment plant in Prudhoe Bay (Kaercher 2001).

Reliability studies determined that the stack injection system at PS 3 failed to reach or maintain operating conditions commensurate with adequate wastewater treatment for 17.5% of the time in CY 2000 (Kinney and Ramos 2001). On the basis of anticipated decline in oil throughput, the studies projected that the stack injection system could be stabilized through 2007, but it would lose its practical viability after that time. Reliability calculations at PS 4 showed its stack injection system to be unavailable for wastewater treatment 7.5% of the time in CY 2000. System viability at PS 4 was projected to last through 2008. System upgrades and changes to operating parameters could potentially extend the lives of the existing systems.

The conceptual study of wastewater management system upgrades at PS 3 and 4 identified various options for domestic wastewater treatment, including (1) installation of a new treatment system at PS 3; (2) improvements to the stack injection system at PS 3 (e.g., installing a dual nozzle configuration); (3) connecting PS 3 facilities to the MCCF package mechanical wastewater treatment system, which would require coincident upgrades to the MCCF system; (4) system upgrades to the stack injection system at PS 4, with increased diversion tank capacity; and (5) a new wastewater treatment system at PS 4 (Kaercher 2001). To date, none of the recommendations of this conceptual study have been selected.

The accuracy of the pipeline throughput projections that serve as the basis for the reliability assessments performed on PS 3 and 4 will ultimately dictate the exact time at which use of the stack injection systems will cease to be viable options for sanitary wastewater disposal. System reconfiguration actions also will affect the point in time when stack injection systems will no longer be sufficient. Regardless of the accuracy of the throughput projections, and irrespective of when exactly system reconfiguration occurs, it is reasonable to assume that stack injection systems at PS 3 and 4 would be replaced with alternative wastewater management systems sometime before expiration of the proposed 30-year Federal Grant renewal. The need to replace the existing system at PS 1 is less certain, but also a possibility.

Domestic wastewater from PS 7, 8, 9, 10, and 12, and the Fly Camp at PS 6 are handled by on-site septic systems (TAPS Owners 2001a). These wastewater treatment systems are the limiting factor at each of the pump stations when considering future staffing capacities (Mikkelsen 1997). The life of the septic systems at these pump stations is not unlimited. In fact, the system at PS 7 is in marginal soils, and it may be difficult to secure the necessary permits for any expansion of this leach field in the future (Mikkelsen 1997).

Therefore, at sometime before expiration of the renewed Federal Grant, the septic systems at PS 7, 8, 9, 10, and 12, and the Fly Camp at PS 6 might have to be expanded, relocated, or replaced with alternative wastewater treatment systems.

The EPA Multi-Sector General Permit for Industrial Activities controls discharges of storm water from 12 industrial areas along the ROW and at the Valdez Marine Terminal. This permit contains requirements for best management practices to control the quality of storm-water runoff. It is assumed that future discharges would be similar in character and volume to historic discharges (see Section 3.16.4 and Appendix C). It is also assumed that the system currently in place to divert storm water from the industrialized areas of the Valdez Marine Terminal to the BWTF for treatment would remain functional, regardless of changes that might occur to the other influents to the BWTF.

4.3.12.6 Special Wastes

Special wastes associated with TAPS operations and their current management schemes were identified in Section 3.16.5. Special wastes are generated at relatively small volumes or on very sporadic schedules. Nevertheless, some constituents of these wastes have a relatively high potential for human health and/or environmental impacts if improperly managed. No major changes to these management options are anticipated. Anticipated impacts on special wastes are discussed below.

PCB Wastes: PCBs are present in only a few pieces of electrical equipment and light fixture ballasts. Current disposal options are not likely to change in the foreseeable future. No significant amounts of PCB-containing waste are anticipated in future years. Also, it is not anticipated that pieces of PCB-containing equipment would be taken out of service before the end of their useful lives. Light fixtures are currently being replaced.

Asbestos Waste: Very little asbestos-containing material (ACM) is present in the TAPS. No changes in the rates of asbestos waste generation are anticipated. Asbestos waste would be generated when equipment with ACM is repaired or replaced. Such actions would continue to be performed by APSC personnel. Small amounts of ACM waste generated would be sent to out-of-state permitted disposal facilities. Asbestos waste would be generated when infrastructure remodeling involves disturbance of ACM building components. Licensed contractors would perform such removal or remediation actions. Asbestos waste from removal or remedial actions would be disposed of in the Palmer Landfill.

Pesticide Waste: Very limited pesticide usage now occurs along the TAPS. Circumstances of pesticide usage are not expected to change in the foreseeable future.

Drag Reducing Agent: Amounts and management procedures for drag reducing agent are not expected to change (see Appendix C, Section C.6.4).

Spent Glycols: All spent glycols that are currently generated are recycled through a private contractor. Recycling is expected to continue. Adoption of RCM-based maintenance postures might affect the maintenance intervals for some equipment and, therefore, also change the volume of waste glycols produced over time.

Tanker Garbage: No changes to the management procedures for tanker garbage are expected. Volumes of tanker garbage would decrease with lower crude oil throughputs because of less frequent tanker berthings at the Valdez Marine Terminal.

Medical Waste: Very small amounts of medical wastes are produced. Volumes are not expected to change. The current management procedures would continue. However, if pump station or Valdez Marine Terminal incinerators stop operating, medical wastes from those locations are likely to be diverted to the closest municipal landfill that can receive such wastes. Landfill acceptance criteria may require sterilization before disposal.

Spent Sandblast Media: No changes to the character of spent sand blast media that result from corrosion control activities are anticipated (see Section 4.3.12.3). RCM-based maintenance strategies could affect the volumes of spent media generated, although not substantially. Disposal options would continue unchanged.

Asphalt: APSC would continue to use the ADEC-approved options for disposal of asphalt. Major access road rebuilding projects may allow for the temporary installation of an asphalt "hot mix" plant near the work site. This might create recycling options for the asphalt removed from the affected sections of road.

Radioactive Wastes: Replacement schedules for smoke detectors and self-illuminated signs are likely to continue. No changes in waste volumes or management procedures are anticipated. However, if components containing radioactive materials were replaced with ones having no such materials, radioactive waste volumes would decrease to zero once replacements were completed.

NORM Waste: Eligibility criteria for oil received at PS 1 are critical to preventing NORM wastes generated coincidentally to North Slope oil production from impacting the pipeline or the Valdez Marine Terminal. Provided these criteria remain the same, NORM wastes are not expected to result from continued TAPS operation.

Spill Debris and Remediation Waste: Management of remediation waste and spill debris would continue to be controlled by ADEC-approved site-specific remediation plans. Thermal treatment of contaminated soils is expected to continue to be the main treatment option. No additional soil stockpiles are expected to be necessary. Proposed rules by ADEC would impact cleanup levels and response planning.[7]

4.3.13 Human Health and Safety

The potential environmental consequences on human health and safety from continued operation of the TAPS under the proposed action alternative are evaluated in this section. Two types of impacts from normal operations are addressed — the industrial (physical hazard)

Impacts of Proposed Action on Human Health and Safety

Operations, maintenance, and construction workers at any facility are subject to risks of fatalities and injuries from physical hazards. Over the 30-year renewal period, the estimated annual number of fatalities for TAPS workers is less than one, while the total number of fatalities over the renewal period is approximately six. The estimated annual numbers of recordable injuries (125-153) and lost time injuries (76-92) represent upper bound ranges of the physical hazard risks of injuries to TAPS workers over 30 years. Recent JPO oversight has addressed employee safety concerns and compliance issues related to fire safety and electrical systems.

Potential risks to the general public of chemical exposures resulting from normal operations of the pipeline were also evaluated. Effluent from the BWTF has not been shown to present an elevated carcinogenic risk through the consumption of fish or shellfish. Human health risks from inhalation of TAPS-associated emissions would be below EPA levels of concern. While some persistent, bioaccumulative, and toxic (PBT) chemicals have been detected at elevated concentrations in Alaskan mammal and fish species, normal operation of TAPS is not associated with significant quantities of these chemicals.

7 Changes are being made to Chapter 75 of the ADEC rules to update and modify the regulations and references to guidance documents, to correct errors, to clarify the intent and purpose of the regulations, to update soil cleanup levels, to modify off-site and portable treatment facilities requirements, to add a time frame for appeals, to modify various definitions, to modify and adjust civil penalties, to modify sampling and analysis requirements, and to refine the regulations to be consistent with 18 AAC 78. The public comment period ended on February 11, 2002 (ADEC 2002).

risk to workers (occupational) and the potential risk from chemical exposures to the general public from normal operations. Impacts to human health and safety as a result of potential accidental releases are discussed in Section 4.4.4.7.

4.3.13.1 Occupational

4.3.13.1.1 Physical Hazards. Operations, maintenance, and construction workers at any facility are subject to risks of injuries and fatalities from physical hazards. While such occupational hazards can be minimized when workers adhere to safety standards and use appropriate protective equipment, fatalities and injuries from on-the-job accidents can still occur. Rates of accidents have been tabulated for all types of work, and risks can be calculated on the basis of historical industrywide statistics. Where possible, these statistics have been used to estimate the extent of worker physical hazard risk for continued TAPS operation under the proposed action.

The U.S. Bureau of Labor Statistics (BLS) and the National Safety Council (NSC) maintain statistics on the annual number of injuries and fatalities by industry type (NSC 2000, 2001). The expected annual number of worker fatalities and injuries for specific industry types have been calculated on the basis of BLS and NSC rate data and on the number of annual FTE workers required for operations and maintenance activities along the pipeline. It is assumed that there would be 1,828 operations, contract, and special projects workers at the beginning of the renewal period, decreasing to 1,716 employees in 2010, and remaining at that level until 2034 (TAPS Owners 2001a). (The anticipated decline in operating employment is attributable to the closing of pump stations as a result of reduced throughput.) It is assumed that, in general, the types of activities required of these employees would be similar to those for workers in the transportation and public utilities industrial sector (pipelines are not broken out separately by the BLS), so fatality and injury rates for that sector were used to estimate annual risks to TAPS workers. Specifically, the following incidence rates are used: 11.5 fatalities per 100,000 full-time workers, 7.3 recordable injuries per 100 full-time workers (defined as total OSHA-recordable cases), and 4.4 lost time injuries per 100 full-time workers (defined as total lost workday cases). Annual fatality and injury risks were calculated as the product of the appropriate incidence rate and the number of FTE employees.

On this basis, the annual fatality and injury rates for continued operation of TAPS are shown in Table 4.3-3. No distinctions are made among categories of workers (e.g., supervisors, laborers) because the available fatality and injury statistics by industry are not sufficiently refined to support analysis of worker rates in separate categories.

The estimated annual number of fatalities for TAPS workers is less than 1 (specifically, between 0.20 and 0.21 per year). The total number of fatalities expected over the 30-year renewal period is approximately six, which is comparable to APSC's historical safety performance data showing nine lives lost to date in operations-related incidents (APSC 2001i) (see Table 3.17-1).

The estimated annual numbers of injuries is between 125 and 133 per year for total recordable cases and 76 to 80 for total lost workday cases. These results are based on transportation and public utilities industrywide statistics from the BLS (NSC 2001). For comparison, the number of injuries was also estimated using the incidence rate for the industry classification of "pipelines, except natural gas" (NSC 2000). The estimated annual numbers of injuries based on this subset of self-reported data from NSC member companies is 20 to 21 recordable injuries and 5 lost-time injuries. (For comparison, the actual numbers of recordable and lost-time injuries for both APSC employees and contractors over the period 1995 to 2000 fall in between the BLS- and NSC-based estimates, averaging 68 and 17 per year, respectively (see Table 3.17-1); note, however, that APSC's past occupational injuries may be underreported, as explained in Section 3.17.1.) Thus, the BLS-based estimated annual numbers of recordable injuries (125 to 133) and lost-time injuries (76 to 80) would be expected to represent upper bounds on the physical hazard

TABLE 4.3-3 Annual Occupational Hazard Rates Associated with Continued Operation of TAPS (proposed action)

	Impacts to Workers[a]			
Time Period	FTEs[b]	Fatalities[c]	Recordable Injuries[d]	Lost Workday Injuries[d]
2004-2009	1,828	0.21	133 (21)	80 (5)
2010-2034	1,716	0.20	125 (20)	76 (5)

a All employees and contractors involved in pipeline operations are included in the physical hazard risk calculations.

b The number of FTEs is based on assumptions presented in the Environmental Report (TAPS Owners 2001a) and used in the economics sections of this EIS.

c Fatality incidence rates used in the calculations are the latest (2000) transportation and public utilities industrywide statistics from the BLS (NSC 2001). Fatality incidence rates for the industry classification of “pipelines, except natural gas,” based on reports of NSC member companies, are not provided in the NSC (2000) report.

d Injury incidence rates used in the calculations are the latest (1999) transportation and public utilities industrywide statistics from the BLS (NSC 2001). For comparison, the number of injuries in parentheses are estimated using the latest (1999) incidence rate for the industry classification of “pipelines, except natural gas” (NSC 2000). While these data would appear to be more applicable to the TAPS, they are based on reports of NSC member companies only, so they may not be representative of the pipeline industry.

risks of injuries to operations workers over the 30-year renewal period.

The calculation of risks of fatality and injury from industrial accidents was based solely on historical industrywide statistics and, therefore, it was assumed that any activity would result in some estimated risk of fatality and injury. The use of best management practices for occupational health and safety compliance should reduce future fatality and injury incidence rates.

4.3.13.1.2 Employee Safety Concerns. A 1996–1997 review of the APSC safety program by the JPO (1998c) found that APSC was generally in compliance with state fire, health, and safety standards. That study also found that employee concerns relative to safety were decreasing and that when violations of procedures occurred, action was taken to avoid recurrence. In contrast, a recent JPO survey to evaluate the Alyeska Employee Concerns Program (JPO 2000a) showed continuing issues regarding management response to worker concerns. Allegations of harassment, intimidation, and retaliation against workers raising concerns were numerous. There were also strong indications of a lack of employee satisfaction with steps taken to resolve concerns. In a recent review of identified health and safety hazards (including employee concerns), the JPO concluded that there were “a vast number of items that were abated in a timely manner” (Elleven 2002a).

4.3.13.1.3 Fire Safety Issues. The adequacy of fire safety systems at the Valdez Marine Terminal has been an issue in recent years. In 1999, the reliability of the Valdez Marine Terminal fire safety systems became an issue because of poor maintenance and cost-saving measures taken. Portions of the foam delivery system piping for suppression of a tank fire were found to be clogged by sludge (JPO 2001a). JPO issued three orders to APSC concerning the testing of 18 crude oil storage tank subsurface fire foam systems at the Valdez Marine Terminal (JPO 2001a). APSC committed to conducting annual preventive maintenance tasks to ensure that the fire suppression system remains functional (JPO 2001a). In July 2000, JPO also received and accepted a satisfactory contingency and evaluation plan for a fire at the Valdez Marine Terminal (JPO 2001a).

A Regional Citizens' Advisory Council review in June 2001 (Slye and Semenza 2001) found significant progress in addressing fire safety system deficiencies. Foam delivery system upgrades were underway, equipment purchases had been initiated, and outstanding maintenance tasks had nearly been completed. At the same time, the review warned of potential for decreased attention to maintenance and found inadequate systems for wharf protection. A joint Valdez Marine Terminal and Valdez Fire Department training session was held in October 2001. At that time, remediation of most of the previously identified deficiencies was found to have been completed or scheduled (Loss Control Associates and Semenza 2001). The JPO had also verified that the work satisfied all order requirements and closed the orders in February 2001 (JPO 2001a).

4.3.13.1.4 Electrical Systems Issues. In 1997, numerous violations of the National Electrical Code were found in the installation of the vapor control system for marine tanker loading (JPO 1998a). An assessment conducted by JPO in 1998 consisted of 11 surveillances and resulted in 5 findings and 6 notices of violation (JPO 2000c, 2001a). Follow-up surveillances were conducted in 1999 to verify that the corrections taken in 1998 continued to be effective (JPO 2001a). Results of these surveillances indicated that APSC's electrical code compliance has improved (JPO 2001a).

4.3.13.2 Public

This analysis primarily addresses the potential risk to the general public of chemical exposures resulting from normal operation of the pipeline. The potential for exposure to PBT chemicals is addressed.

4.3.13.2.1 Ballast Water Treatment Facility Effluent. Ballast water from tankers is treated in the Ballast Water Treatment Facility (BWTF) and discharged under an NPDES permit into the waters of Port Valdez. Treated water is discharged through a series of ports in a 63-m-long diffuser positioned at a depth of 62 to 82 m. Low concentrations of polycyclic aromatic hydrocarbons (PAHs) are present in untreated ballast water but have rarely been found above detection limits in the treated effluent. The soluble BTEX pollutants are the pollutants found in the highest concentrations in the BWTF effluent (APSC 1995).

During routine operation of the BWTF, the biological treatment component operates efficiently, and the effluent is well within permit limits. Fluctuating conditions in the biological treatment, caused by interruptions in ballast water flow, are problematic, however, and require special management (JPO 2000b). Efficiency of the biological processing requires a nearly constant supply of oily, relatively warm input water. Disruptions to the flow occur when severe winter storms temporarily shut down tanker loading operations. Such interruptions may increase in the future as oil throughput decreases or ballast water volume is reduced for other reasons (JPO 2000b).

An evaluation of human health risk associated with the BWTF discharge found that the only likely exposure pathway for humans is through consumption of fish or shellfish from affected waters. The propensity of metal and volatile organic constituents of the effluent to bioaccumulate was considered in the risk assessment. Human subsistence consumption levels of 180 g/d of fish and 20 g/d of shellfish were assumed. On this basis, the evaluation concluded that human carcinogenic risk from consumption of fish and shellfish does not exceed 1×10^{-5} (1 in 100,000), and that it does not exceed thresholds for mutagenic or teratogenic risks (APSC 1995). (See Section 4.4.4.7 for further analysis and discussion of the food chain pathway under an accidental spill scenario.)

4.3.13.2.2 Hazardous Air Pollutants in Ambient Air and Potential Health Hazards. The potential human health impacts from inhalation of HAPs in ambient air under existing conditions were discussed in Section 3.17.2.4. For assessment of potential impacts from TAPS-associated emissions, risk calculations were conducted on the basis of ambient HAPs levels for the Valdez area reported in the Valdez Air Health Study (Goldstein et al. 1992), but scaled to represent the varying throughput levels assumed for the duration of the 30-year TAPS renewal period. Again, inhalation risks for the Valdez area are assumed to be a bounding case for all exposures along the pipeline, because HAP emissions from the Valdez Marine Terminal greatly exceed those from the pump stations (Table 3.13-6) and because the pump stations are located as far or farther from residential locations as is the Valdez Marine Terminal.

Specifically, this assessment evaluates the potential health risks from exposures for the period 2004 through 2033 (30 years of exposure). For the residential area risk, a "baseline" risk was added to account for exposures that have occurred since the start of pipeline operations through 2003 (27 years). The hypothetical worst-case assessment used ambient levels at the Valdez Marine Terminal fenceline (although no people currently reside at that location), and the assessment for residential exposures used ambient levels measured in Valdez residential areas. No baseline risk was added for the worst-case assessment, because residential exposures at the fenceline have not occurred to date.

The three residential monitoring locations and the fenceline location are shown in Figure 4.3-3. The three assumed operational throughput values (i.e., 0.3, 1.1, and 2.1 million bbl/d) were used to scale assumed ambient concentrations from the levels observed at the time of the Valdez Air Health Study (when throughput was 1.8 million bbl/d). A summary of the assessment results is given in Table 4.3-4. On the basis of a tracer study, the Valdez Air Health Study estimated that Valdez Marine Terminal emissions only contributed up to about 10% of the residential area HAP levels; the other 90% was likely from use of home heating fuels and household solvents. Therefore, only 10% of the measured residential area ambient HAP concentrations were scaled with assumed change in throughput; the 90% attributable to other sources was assumed to remain constant throughout the assessment period.

No noncancer adverse health impacts to members of the general public would be expected from inhalation of TAPS-associated emissions during the renewal period. Also, at Valdez residential locations and for all assumed throughputs, the increased lifetime cancer risk would be essentially the same, and below levels of concern established by the EPA. The levels and risks are essentially the same because the predominant source of ambient VOC levels in the residential area was found not to be the Valdez Marine Terminal.

For the Valdez Marine Terminal fenceline location, ambient levels and potential cancer risks were less than the EPA's level of concern of 1×10^{-4} for all assumed throughputs (see Table 4.3-4). In addition, for the worst-case fenceline assessment, it is unlikely that a member of the general public would be exposed to benzene at the fenceline concentration for prolonged periods; currently no one resides that close to the Valdez Marine Terminal. The vapor collection system installed in 1998 on two of the four tanker berths at the Valdez Marine Terminal decreased VOC emissions by a factor of more than 10 (see Section 4.3.9). Therefore, current Valdez Marine Terminal-attributable fenceline benzene concentrations (and associated cancer risks) would be expected to be much lower than those measured in the Valdez Air Health Study because of the reduced emission levels. However, the Valdez Air Health Study risk estimates are of interest for the purpose of bounding the potential risks from TAPS emissions.

TABLE 4.3-4 Potential Human Health Risks Associated with Inhalation of Hazardous Air Pollutants in Valdez Area Ambient Air[a]

	Risk, by Pipeline Throughput Level (10^6 bbl/d)		
Parameter	0.3	1.1	2.1
Cancer Risks[b]			
Residential area exposure[c]	3.0×10^{-5} (3.0×10^{-6})	3.1×10^{-5} (3.1×10^{-6})	3.2×10^{-5} (3.2×10^{-6})
Hypothetical worst-case exposure (fenceline)	1.2×10^{-5}	4.1×10^{-5}	8.6×10^{-5}
Hazard Index[d] *(noncancer hazards)*			
Residential area exposure[c]	0.05 (0.005)	0.05 (0.005)	0.05 (0.005)
Hypothetical worst-case exposure (fenceline)	0.07	0.22	0.46

a Risks were estimated for a 70-kg adult exposed daily. Pollutants included in the risk assessment were benzene (the only carcinogen), ethyl benzene, n-hexane, toluene, and xylene. Pollutant concentrations are 1991 data from Goldstein et al. (1992); values were scaled to the various assumed pipeline throughput levels.

b Risks between 10^{-6} and 10^{-4} are generally considered below the level of concern.

c Exposures in residential area of Valdez, based on 1991 ambient VOC concentrations. For residential cancer risks, a baseline risk of 1.5×10^{-5} from 27 years of exposure (1977–2003) was added to the risk from exposure during the proposed action period of 30 years (2004–2033). Values in parentheses represent the approximate risk and hazard index contribution (i.e., less than 10%) from the Valdez Marine Terminal (based on 1991 ambient VOC concentrations before installation of a vapor-collection system in 1998). Since installation, the Valdez Marine Terminal VOC emissions have decreased by a factor of more than 10, thereby further decreasing the terminal's contribution to ambient VOC levels.

d A hazard index of <1 means adverse health impacts are unlikely.

4.3.13.2.3 Potential for Exposure to PBT Chemicals. As discussed in Section 3.17, some PBT chemicals have been detected at elevated concentrations in Alaskan fish and marine and terrestrial mammal species. The PBT substances of greatest concern are PCBs, mercury, radionuclides, and PAHs.

PCBs and mercury have not been associated with TAPS construction or operation to date, and would not be used during the proposed renewal period. Production of PCBs has been banned since the late 1970s, and most electrical equipment containing PCBs in the United States has been removed and disposed of according to existing regulations. Mercury-containing substances are also not generally in use or storage for TAPS operations, although some equipment such as electrical switches, batteries, and thermostats may contain small amounts of mercury (EPA 2001a). Radionuclides are not associated with TAPS operation but may be associated with deconstruction under the no-action alternative as discussed in Section 4.6.2.13. PAHs are components of crude oil and refined oil products, as well as tobacco smoke and incomplete combustion emissions. Normal operation of the TAPS is not associated with significant PAH releases; however, a spill with or without associated fire could release large quantities of PAHs to the environment (see Section 4.4.4.7).

Click here to view Figure 4.3-3

FIGURE 4.3-3 Valdez Air Health Study Ambient Air Monitoring Locations

4.3.14 Biological Resources Overview

Direct and indirect effects of the proposed action on biological resources are discussed in this section. The region of influence for direct effects encompasses the footprint and vicinity of the 800-mi-long TAPS ROW and associated facilities, including the Valdez Marine Terminal, pump stations, material sites (quarries), disposal areas, previously contaminated sites, support facilities (e.g., airports, access roads, and work camps), and the gas fuel line that supplies gas to PS 1 to 4. The region of influence for indirect impacts includes adjacent areas that would be affected secondarily by activities within the project footprint. Examples include areas adjacent to pump stations affected by noise, the Dalton Highway (used to transport materials and people to various locations along the pipeline), and areas affected by runoff from the TAPS workpad or other surfaces. Such areas could include upland, wetlands, or surface water bodies.

Factors associated with the proposed action that could affect biological resources include facility existence, normal operations, monitoring, maintenance, and accidental releases (spills). These factors are described in Section 4.2, and mitigation measures to reduce their impacts are described in Section 4.1. These factors could affect biological resources by altering habitat characteristics and the species supported by those habitats. Impacts of spills are discussed in Section 4.4.

Facility existence (the physical presence of the TAPS and associated facilities without operation or maintenance) affects biological resources because vegetation, fish, and wildlife are displaced; existing habitats are fragmented; ROW habitats are maintained in an altered condition; the movements of fish and wildlife are at times obstructed; and human access is provided to otherwise inaccessible areas. Impacts of facility existence originate from the original TAPS construction, but the proposed action would extend those impacts into the future. Biological impacts of facility existence would for the most part be limited to the ROW and vicinity and are described in Sections 3.18 through 3.22.

Normal operations of the TAPS include oil pumping, transportation of materials and supplies, waste management activities, maintenance, monitoring, and security operations. Impacts of normal operations are expected to be similar to those that have occurred over the history of TAPS operation and would be limited primarily to the ROW and areas of associated facilities. They include habitat modification; impacts to water temperature in areas where the pipeline is buried in and adjacent to streams; changes in permafrost patterns and the occurrence of thermokarst resulting from the pumping of warm oil through the pipeline; noise and disturbance resulting from human activities especially at the pump stations, Valdez Marine Terminal, and Dalton Highway; effluent discharge from the Valdez Marine Terminal and other facilities; and effects on air quality from emissions at pump stations, the Valdez Marine Terminal, and transport vehicles along the Dalton Highway.

Maintenance includes those activities needed to ensure that the TAPS performs normally. Maintenance activities that would occur during the renewal period include vegetation management, repair of below-ground mainline pipe, maintenance of slopes and the workpad, potential pipe replacement projects, valve maintenance, maintenance of cathodic protection, maintenance and repair of river crossing and training structures, maintenance and repair of the fuel gas line, and quarry operations at material sites. Maintenance activities could result in impacts to areas within and outside of the ROW. While these impacts would be similar to those resulting from facility existence, they could involve additional areas that are not currently disturbed.

The biological resources assessment focuses on the effects of environmental changes resulting from the proposed action on terrestrial and wetland vegetation; fish; birds and mammals; and threatened, endangered, and protected species. Impact significance was determined on the basis of the areal extent of the change, including the project footprint and affected adjacent areas; characteristics of the area affected; the magnitude of the change (deviation from the baseline) anticipated; the season when the impact would occur; the duration of impacts; the sensitivity of biological resources to change; and the rarity and importance of the resource.

4.3.15 Terrestrial Vegetation and Wetlands

Terrestrial vegetation and wetland communities and their component species may be affected by factors associated with the presence of TAPS facilities, normal operations, monitoring, and maintenance under the proposed action. Impacts from potential accidental releases under the proposed action are discussed in Section 4.4.4.9.

4.3.15.1 Impacts of Facility Presence

Construction of the TAPS, including the ROW, pump stations, Valdez Marine Terminal, material sites, disposal sites, and the Dalton Highway, resulted in the elimination of extensive areas of terrestrial and wetland communities (see Section 3.18). This loss and alteration of terrestrial and wetland vegetation communities would persist throughout the renewal period under the proposed action.

In most areas along the ROW, post-construction revegetation activities have resulted in the establishment of a vegetation community composed of planted species, some of which are nonnative, with varying degrees of invasion by native species (McKendrick 2002). Over the time period considered in this analysis, vegetative cover would be expected to continue to increase, through growth and reproduction, on most portions of the ROW that currently lack complete cover.

Some upland tundra locations, such as occur near Atigun Pass, may continue to lack sufficient fine soil particles to support vegetation. Some native species present within adjacent communities would continue to invade the ROW, resulting in an increase in the distribution and abundance of native species over the renewal period. However, the differences in substrate characteristics between the ROW and adjacent undisturbed areas (including moisture levels, organic surface layer, and gravel content), and the vegetation management program may preclude the establishment of mature communities typical of undisturbed areas in the vicinity of the ROW over the course of the renewal period (McKendrick 2002). Instead, earlier successional communities, similar in species composition to disturbance sites (e.g., riparian zones, avalanche chutes) will persist.

Sedimentation impacts may occur at any point along the ROW; however, the occurrence of such events would likely be very infrequent during the renewal period. Erosion of the ROW due to unanticipated stream flows, such as occurred near MP 752 in the early 1980s and elsewhere (TAPS Owners 2001a), can result in degradation of wetland and terrestrial plant communities downgradient of the ROW. Construction materials eroded from the ROW may cover existing vegetation where redirected stream flows occur, or sediment may be dispersed downstream of ROW river crossings, affecting streamside wetlands or floodplain communities. Herbaceous or low-growing woody species that become covered by sediment may be injured or killed. Vegetation effects in areas affected by sediment may result from reduced photosynthesis or leaf surface gas exchange. Physical effects include reduced oxygen availability in the root zone or changes in soil chemistry or moisture levels. Total vegetative cover may be reduced because species less

Impacts of Proposed Action on Vegetation and Wetlands

Impacts of the proposed action on terrestrial vegetation and wetlands would be similar to impacts of current pipeline operations. For the most part, differences between vegetation types in the ROW and those in surrounding areas would continue. In addition, localized disturbances to vegetation (with subsequent restoration) in the immediate vicinities of pipeline maintenance and repair activities and in association with extraction of sand, gravel, and quarry stone for pipeline-associated needs would generally be expected to continue at rates similar to current rates.

tolerant of sedimentation may be eliminated, resulting in a shift in community structure toward more sediment-tolerant species. Although removal of sediments and other surface water contaminants is a function of wetlands, excessive sediment input can reduce or eliminate this functional capacity. High sediment inputs can fill wetlands, converting wetland plant communities to upland communities as soil surface elevation increases and soil moisture levels decrease from alteration of drainage patterns. Some areas of sediment accretion in unvegetated river channels may become colonized by pioneering plant species.

Surface water drainages that traverse the ROW through culverts or low water crossings may occasionally become blocked by the accumulation of ice, debris following high flows, or by beaver activity (APSC 2001j). Although maintenance activities have reduced the occurrence and duration of such blockage, temporary blockages may continue to occur on occasion (TAPS Owners 2001a) and may promote the development of wetland communities as upland vegetation or exposed soils are replaced with hydrophytic vegetation. Terrestrial communities, however, may be lost and replaced by unvegetated ponds where surface water is too deep for the establishment of wetland communities. Existing wetland communities along blocked drainages may, however, be altered or eliminated by the increase in depth or duration of surface water. Ice-rich permafrost in upland soils may be affected by inundation of the soil surface (TAPS Owners 2001a). Upper portions of the permafrost may become thawed, leading to thermokarst, or collapse of the soil structure. Continued expansion of the area of thermokarst as adjacent permafrost thaws may lead to increasing losses of the vegetation communities, both terrestrial and wetland, in the affected area.

The existence of the ROW has resulted in increased vehicle use near the ROW and associated impacts to vegetation. Effects of vehicle use can include injury or destruction of vegetation, increased erosion in areas of damaged vegetation or on disturbed soils, and changes in soil characteristics, such as moisture levels or compaction. These changes can alter plant community structure or even eliminate vegetation. Exposure of the soil surface in areas of shallow permafrost, especially if associated with the creation of shallow depressions, may result in the development of thermokarst. Adjacent vegetation communities may be lost as thermokarst expands and the area becomes inundated. However, the pattern and level of use over the renewal period would likely be similar to past levels. Most past use has occurred during winter snow cover when potential effects are minimized.

Terrestrial and wetland plant communities and surface waters downgradient from the workpad, existing material sites, disposal sites, or other disturbed areas may receive sediments from storm-water flows over exposed soil or gravel surfaces. However, current maintenance practices have reduced the occurrence of sedimentation (TAPS Owners 2001a). Impacts of storm-water runoff from the workpad or other areas to surface water are expected to be local and temporary (see Section 4.3.6). Impacts from storm-water runoff generally would not be expected to result in a measurable change in terrestrial vegetation and wetland communities. Any sedimentation impacts to wetland communities, however, could reduce the functional capacity of those wetlands for storm-water retention.

4.3.15.2 Impacts of Normal Operations, Monitoring, and Maintenance

Normal operations of the TAPS and monitoring activities throughout the renewal period, for the three throughput rates (0.3 million, 1.1 million, and 2.1 million bbl/d) evaluated under the proposed action, are expected to continue at levels similar to those of the past. Those activities would include vehicular traffic along the ROW, routine activities associated with the workpad, and pump station operations, including landspreading of treated wastewater, water use, and use of septic fields. Continued occasional disturbance to terrestrial vegetation and wetland areas along the ROW would maintain these communities in present conditions (such as the continued reduction of vegetation in vehicle tracks along portions of the workpad) (McKendrick 2002). In addition, impacts to surface water and groundwater (which could indirectly affect terrestrial and wetland vegetation) as a result of normal operations would be local and temporary (see Sections 4.3.6 and 4.3.7).

Airborne dust generated by traffic along the Dalton Highway results in a “dust shadow.” Deposition of fugitive dust on leaf surfaces can result in adverse impacts to vegetation by reducing photosynthesis and leaf surface gas exchange. Some moss and lichen species are especially sensitive to road dust (Everett 1980). Fugitive dust can also alter soil characteristics and affect water quality. Extensive deposition can reduce growth or survival of vegetation and alter the species composition of affected communities.

Dust Shadow

A “dust shadow” results from the settling of airborne dust along an unpaved highway. The accumulation of settling dust is most noticeable near the highway and decreases dramatically with distance. The area beyond 1,000 ft from the Dalton Highway is unaffected by this “dust shadow.”

Storm-water flows from areas of heavy dust deposition on uplands can deposit sediment into adjacent wetlands and waterways with results similar to the impacts of erosion. The areas along the Dalton Highway potentially affected are currently in a disturbed condition from past deposition (TAPS Owners 2001a). These vegetation communities would remain disturbed and would not likely improve from their present condition. Therefore, additional impacts to terrestrial and wetland vegetation communities, both within and outside of the ROW, from normal operations and monitoring would not result in measurable changes in these communities.

Operation of the pump stations and Valdez Marine Terminal would continue to generate air pollutants. However, the levels of emissions of these pollutants would not be expected to result in detrimental effects on vegetation. Although no direct studies of air emission effects on vegetation near these facilities have been conducted, predictive evaluations have indicated that no detrimental effects to vegetation would occur from turbine rim cooling at PS 2 and 7, and significant impacts to vegetation from Valdez Marine Terminal tanker vapor recovery emissions would be highly unlikely (TAPS Owners 2001a). Minor increases in nutrient availability to plants may occur due to emissions and may result in higher productivity of some plant species near the pump stations and Valdez Marine Terminal.

Routine maintenance activities associated with continued operation of the TAPS would likely include a variety of ground-disturbing activities (APSC 2001j; TAPS Owners 2001a). These activities would include excavation or grading of areas within the ROW, primarily on the workpad. These excavations would remove existing vegetation within the work area and might result in the unavoidable filling of wetlands in the ROW with fill material or temporary draining of wetland areas. However, most activities would affect previously disturbed and replanted areas of the ROW. These actions might result in the erosion of soil or gravel, with subsequent sedimentation of surface waters, including wetlands, downgradient of the work site. Because of current erosion control procedures, impacts to surface water as a result of most of these activities are expected to be local and temporary (Section 4.3.6). Any sedimentation impacts to downstream wetlands, however, could reduce their functional capacity. Potential future upgrades to the pipeline or pump stations may also include similar types of ground-disturbing activities with resulting impacts to vegetation.

Following regrading, the disturbed areas would be restored by methods currently used in revegetation efforts. Revegetation procedures are evaluated and approved for each project by AO and the SPC. The methods used for revegetation would be modified according to site-specific conditions. Disturbed areas would be restored as soon as practical. Restoration must meet performance requirements, which include "remove all contaminated material; to the extent possible, return a disturbed site to its original or normal physical condition and natural biological productivity and diversity with reestablishment of native plant and animal species; prevent erosion; conform to the adjoining land forms and approximate the original land contours; maintain pipeline system integrity; remove improvements as required by the appropriate authority; and provide for public safety" (Brossia and Kerrigan 2001). Disturbed areas would be allowed to be revegetated primarily with native species found in adjacent natural areas. Diverse communities of local native species would be expected to develop on the restored areas. When maintenance work was not done during winter, soil compaction from the use of heavy equipment might alter soil moisture characteristics as well as soil structure and might initially hinder the reestablishment of native species.

Some areas, such as those that may be more susceptible to erosion or are difficult to revegetate, would be seeded with native perennial grasses (such as native varieties of red fescue and Bering hairgrass) and nonpersistent annual ryegrass, and mulched if necessary. A comparatively short period may be required for vegetation to become established on lightly seeded areas and for native communities to become well established (McKendrick 1999; APSC 1998e). Because native seed would be used for revegetation, the introduction of nonnative species would be limited (although nonnatives may become introduced in mulch).

Routine maintenance would include repairs of corroded sections of buried pipeline, which may entail 15 to 20 excavations per year (an increase from the present level of approximately 14 per year), resulting in a total disturbed area of 3.4 to 4.6 acres per year. Corrosion repairs would affect vegetation communities within the ROW that had been previously disturbed by TAPS construction and revegetated. Many maintenance excavations (those requiring extensive dewatering) would occur during winter, thus minimizing impacts to vegetation outside the excavation areas (TAPS Owners 2001a). Existing vegetation within the ROW would be removed during excavation, and revegetation would be undertaken after final grading. Corrosion repairs might be required in any segment of the pipeline and occasionally could take place in areas of high groundwater levels, such as near wetlands. Dewatering of the excavation and discharge of water is not expected to result in measurable impacts to groundwater (Section 4.3.7) and would only result in local and temporary impacts to surface water (Section 4.3.6). Replacement of belowground refrigeration units would have similar impacts to vegetation (no measurable impacts to groundwater and surface water) and might disturb up to 25 acres of vegetation within the ROW over the entire renewal period, requiring revegetation efforts. Repairs of pipeline cathodic protection might also require excavation within the workpad and subsequent revegetation. Maintenance of belowground valves may result in the disturbance of 0.3 acre per year within the ROW.

Maintenance of the workpad and slopes within the ROW may require regrading and revegetation of areas previously disturbed by TAPS construction. Also, highly sloped areas adjacent to the ROW may require grading or stabilization. Vegetation communities that are currently undisturbed may be removed by slope stabilization efforts. Replanting would establish vegetative cover on the affected area; however, extended periods may be required for native communities to become reestablished on alpine slopes (McKendrick 2002). Soil compaction from the use of heavy equipment may hinder the reestablishment of native species where work is not performed during winter.

Workpad maintenance also includes the clearing of drainage structures where accumulated debris has resulted in the impoundment of surface water. As the impoundments subsequently drain, the artificial wetland communities that developed may revert to the former terrestrial community type through colonization of species from adjacent undisturbed areas. Areas of exposed soil may create an opportunity for the invasion of nonnative weedy species. However, no invasion of undisturbed areas immediately outside the TAPS Row was observed in a 1999 survey (McKendrick 2002).

Routine maintenance of the ROW also would include activities related to the revegetation program and the vegetation management program, which includes the control, or brushing, of woody species. Trees and tall shrubs are periodically cut back near the pipeline to maintain access and reduce woody root growth near buried pipe sections. The JPO brushing policy addresses the values of vegetation protection and the need for maintenance access to TAPS structures (Brossia and Britt 2001). Brushing is conducted within the ROW, including the drivelane to 6 ft beyond the pipe centerline and within 10 ft around each vertical support member. Brushing is also conducted within 10 ft of culvert inlets and outlets. A 20- to 50-ft buffer zone, within which no vegetation is cut or disturbed (with minor exceptions) without approval of the AO and SPC, is maintained around all water bodies. Outside the buffer zone, vegetation disturbance is minimized to that necessary for maintenance activities.

Vegetation control would maintain plant communities in some portions of the ROW in early successional stages of community development (McKendrick 2002). Also, the presence of the gravel pad may not allow the development of mature natural communities. Native shrubs would continue to increase in segments of the TAPS ROW within the lowland tundra and upland tundra zones through reproduction and invasion from nearby undisturbed plant communities. Vegetation management in the boreal forest and coastal forest zones would continue to suppress the growth of forest tree species (such as black spruce, white spruce, or Sitka spruce). The vegetation management program maintains shrub and herbaceous plant communities through forested segments of the ROW.

Pipeline replacements and subsequent impacts to vegetation are not expected during the renewal period because of current monitoring and early repair procedures. Four replacements have occurred since pipeline completion, including 9.3 mi of new construction. The replacement of pipeline sections would result in extensive disturbance to the ROW, including existing terrestrial and wetland vegetation. Pipeline replacement within the ROW involves the removal of existing vegetation that has become reestablished since the original construction activities, and might result in impacts to wetland areas, especially where the ROW does not presently contain a gravel pad. Rerouting pipeline segments would destroy vegetation in currently undisturbed areas and might result in the filling or drainage of undisturbed wetland areas.

ROW maintenance might also include the placement of riprap or other materials where flooding has induced erosion of the ROW (and may have exposed the pipeline) or adjacent streambanks, such as occurred along the Sagavanirktok River in 1992 (TAPS Owners 2001a). The effects of such maintenance activities are primarily restricted to the ROW, which may be unvegetated in portions located within stream channels. Repairs within the ROW may require disturbance to terrestrial or wetland vegetation. However, such disturbances primarily affect previously disturbed areas that were replanted following pipeline construction. These areas would again be revegetated following completion of repairs.

Remedial measures may require placement of armoring materials, such as riprap, in stream channels or along stream banks to prevent future threats to the pipeline. Preventive maintenance may also include the construction of guidebanks or revetments (armoring placed along a bank to stop erosion, such as along the Middle Fork Koyukuk River in 1994 and 1998 and Tazlina River in 1999), new spurs along stream channels (Middle Fork Koyukuk River in 1995), or stream channel stabilization (Marion Creek, Minnie Creek, and Oskar's Eddy in 2000). Revetment and guidebank construction generally includes grading of the streambank and extensive placement of riprap along the bank and in the adjacent streambed (TAPS Owners 2001a). Riparian vegetation along the bank and upland vegetation along the crest of the bank may be removed during grading. Wetland communities in the streambed may be eliminated. Because severe erosion of the streambank typically necessitates revetment construction, vegetated wetlands are typically absent from the construction site except at the upstream or downstream ends.

Construction of spurs often includes the extensive placement of material in streambeds and may entail the removal of terrestrial and wetland plant communities during excavation and material placement. Extensive stream channel migration toward the pipeline caused by erosion at a sharp bend may require that the channel be moved back to a prior location. The moving of a stream channel as a preventive measure involves the initial destruction of any plant communities present because of construction activities, including grading and placement of riprap. Extensive wetland communities may be present in shallow, low-velocity areas on the inside bend. However, regrading of the floodplain may provide the opportunity for establishment of both wetland and terrestrial communities through revegetation efforts.

Construction activities along stream and river margins would also generate airborne dust and sedimentation. Dust emissions over the course of a single project would be local and temporary (Section 4.3.9). Impacts to surface water from sediment inputs to the stream or river are expected to be local and temporary (Section 4.3.6).

Maintenance and repair of the buried fuel gas line may also result in impacts to natural terrestrial and wetland vegetation. Several hundred feet of the line require regrading and backfilling each year. Although repairs are generally conducted during winter when indirect impacts are minimized, vegetation would be removed within the repaired area. The affected vegetation communities would be predominantly those communities established since gas line construction. A gravel workpad is absent from the gas line corridor, and natural terrestrial and wetland vegetation communities may be affected by burial under graded material, soil compaction, or disturbance by heavy equipment and other vehicles.

The development of new material sites would likely occur because of an anticipated need for 100,000 yd^3/yr of materials over the renewal period. Any removal of gravel and other construction materials from material sites would likely result in additional impacts to terrestrial vegetation and wetland areas at existing sites. The vegetation communities affected by material site development or expansion would be heretofore undisturbed communities located outside the ROW. Vegetation, possibly including wetland communities, would be removed as the sites were expanded. Sedimentation resulting from such operations might affect wetlands downstream of material sites and wetlands adjacent to material sites located along stream channels. Adjacent vegetation communities might be eliminated or affected by changes in drainage patterns at or near the sites, which might result in either a decrease or increase in the frequency or duration of substrate saturation.

4.3.16 Fish

Because of the proximity of the TAPS ROW to aquatic habitats along much of its length, various impacting factors can result in environmental changes that could affect fish. Specifically, barriers to fish movement, changes in water surface flow patterns, deposition of sediment in surface water bodies, changes in water quality or temperature regimes, contamination of water, loss of riparian vegetation, and changes in human access to water bodies are the environmental changes most likely to affect fish. This section describes the impacts from these environmental changes, broadly grouped into impacts that result from (1) alteration or loss of fish habitat, (2) obstructions to fish passage, and (3) increased human access. Potential impacts to fish associated with spills or releases of oil are addressed in Section 4.4.4.10.

Impacts of Proposed Action on Fish

The proposed action could have the potential to produce impacts to fish habitat, but continued operations are not expected to substantially affect fish populations during the renewal period.

4.3.16.1 Impacts of Alteration and Loss of Habitat

Alteration and loss of habitat can result from bank hardening, draining water bodies, changing or temporarily diverting river or stream channels, excavating streambed materials (e.g., gravel), removing riparian vegetation, or causing changes in water quality parameters (e.g., turbidity, sediment deposition, temperature, and chemical constituents) that affect the ability of fish to utilize specific locations. Changes in habitat can result in a variety of impacts to fish, including direct mortality and changes in population size, population structure, reproduction, and growth rate. For this reason, ADF&G permits are required under Alaska Statutes, Title 16, for activities in or near fish streams that could affect anadromous fish and their freshwater habitat or the free and efficient migrations of resident fish. Alteration or loss of essential fish habitat is of particular concern in waters and substrate necessary for spawning, feeding, or growth to maturity. Projects with a potential to affect marine habitats or anadromous fish streams are given special consideration. Under the authority of TAPS Stipulation 2.5.3.1, the BLM has designated all fish streams crossed or closely associated with the pipeline ROW as zones of restricted activities. Approval to work in streams normally requires notification of appropriate environmental specialists in conjunction with submittal of an ADF&G Title 16 permit application (APSC 1998a). The final decision on whether a permit is required for a specific activity rests with the ADF&G.

Overwintering has been identified as an especially sensitive period for fish inhabiting arctic and subarctic freshwater environments (Power 1997; Reynolds 1997; Moulton and George 2000). Because overwintering areas are scarce in many river systems along the TAPS, fish movement can be restricted, and fish tend to be concentrated in specific areas during winter months. As a consequence, mortality to a large portion of a fish population can result when flow is altered in an overwintering area or water quality is degraded by introducing sediment, altering turbidity, temperatures, or contaminant levels. Such effects to overwintering areas were identified as concerns during Sagavanirktok River flood repairs and corrosion digs in 1993 and 1994, Dietrich River spur dike construction and Phelan Creek corrosion digs in 1993 (SPCO 1993, 1995), and construction of the Dietrich River revetment in 1999. To reduce the potential for adverse effects on overwintering fish, the ADF&G does not authorize water withdrawals in overwintering areas. Permits issued by the ADF&G typically require activities in known overwintering areas to be conducted during open-water periods or with engineering controls in place. Erosion control measures commonly used for maintenance and repair operations are identified by the APSC (1998c, 2001j).

Turbidity and sedimentation from erosion are part of the natural cycle of physical processes in water bodies, and most fish populations are adapted to short-term changes in these parameters. However, if sediment loads are unusually high, last for extended periods of time, or occur at unusual times of the year, adverse impacts can occur. Increased sediment can decrease fish feeding efficiency, reduce levels of invertebrate prey species, and decrease fish spawning success. Deposition of fine sediment on to spawning gravels can adversely affect the survival of incubating fish eggs, alevin, and fry. Activities that increase turbidity and sedimentation during the overwintering period for fish are of particular concern because fish are often restricted to specific areas and are already stressed by cold temperatures and low availability of food.

DenBeste and McCart (1984) reported that erosion of the workpads associated with TAPS structures could lead to sedimentation in some water bodies. It is anticipated that under most conditions, the impacts of sedimentation related to normal erosion would be relatively minor, as it would be most likely to occur during wet periods of the year when turbidity in streams is naturally higher. Potential impacts may be somewhat higher in some stream systems (e.g., Hess Creek) because they remain relatively clear even during rainfall events. In addition, there has been progressive restoration of stream banks and erosion control over the years since the TAPS was constructed.

Sedimentation during pipeline construction and maintenance activities was recognized early as potentially affecting fish habitat (USFWS 1970). Under the proposed action, activities such as culvert replacements, modification of stream crossings, and excavations and replacement of pipeline components located near water bodies would be most likely to result in sedimentation. Increased turbidity resulted from instream gravel mining during pipeline construction (Woodward-Clyde Consultants 1980) and, although less extensive than in the past, gravel mining would continue to occur under the proposed action. With current operations, ADF&G issues permits that specify restrictions, control measures, and monitoring and mitigation actions for TAPS-related construction or excavation projects. When feasible, activities are avoided during winter months in areas where overwintering fish may be affected. Typical monitoring required by ADEC and EPA includes baseline measurements upstream of the project, in the mixing zone immediately downstream of the project, and downstream of the mixing zone. Effective use of the ADF&G permit review processes would minimize the adverse effects of normal operations and maintenance along the TAPS ROW (SPCO 1993, 1995).

Airborne dust resulting from vehicle traffic along unpaved portions of the Dalton Highway is another potential source of sediment introduction into streams. This dust can get into streams either directly by falling into the water from the air or indirectly in runoff from erosion of dust that settled on areas adjacent to streams. Because the highway crossings of streams are only very short segments and the dust typically falls out within 300 ft of the roadway, the amount of sediment introduced into individual streams is expected to be very small and would be unlikely to affect fish populations.

In some cases, habitat alteration may provide some benefit to aquatic systems. For example, at MP 47, a spur dike caused a scour pool that added overwintering habitat in the Sagavanirktok River (Martin et al. 1993). Pits created by gravel mining in inactive floodplains of the North Slope have been shown to provide overwintering habitat for fish in some cases (Woodward-Clyde Consultants 1980; Hemming 1995). Hemming (1995) also reported that spawning success by Arctic grayling was indicated for two gravel extraction sites associated with the Kuparuk River. Additional overwintering habitat has also been created by ponding of water near the Atigun River at approximately MP 160. However, most fish using the Atigun River move downstream and overwinter in Galbraith Lake. Channels connecting the ponded area to the main river have been modified to allow overwintering fish (primarily Arctic grayling) better access to the river when flows increase in the spring.

Fish may also be affected by deposition of airborne pollutants onto surface waters. Modeling studies carried out for TAPS PS 2 and 7 for the addition of turbine rim cooling in 1990 included an evaluation of impacts of gaseous emissions on nearby wildlife (APSC 1990c). Air quality effects on anadromous fish in the Sagavanirktok and Chatanika Rivers were evaluated. The Sagavanirktok is about 0.1 mi east of PS 2, while the Tatalina River (a tributary to the Chatanika) is approximately 1.5 mi north of PS 7. The predicted levels of nitrogen oxides and sulfur dioxide for both river systems were below EPA screening levels, and significant impacts to fish were not anticipated.

There is a potential for discharges from the BWTF and the sanitary water treatment plant at Valdez Marine Terminal to affect fish in Prince William Sound. However, as reported in Section 3.11.1, discharges from both of these sources are in compliance with permitted levels (see also Section 4.3.8). The resulting pollutant concentrations in Prince William Sound are unlikely to have significant impacts on fish. In addition, concentrations of hydrocarbons in sediments near the ballast water diffuser in 1999 were found not to exceed sediment quality guidelines and, thus, are unlikely to impair sediment quality (Feder and Shaw 2000).

A potential also exists that nonindigenous organisms could be introduced into Prince William Sound with discharges from the BWTF. Under the proposed action, the BWTF would continue to receive ballast water from tankers utilizing nonsegregated ballast water (i.e., the ballast water is carried in oil-holding compartments) in order to removed the oil residues contained within the ballast water. As discussed in Section 4.3.8.1, the amount of water treated in the BWTF should decrease during the renewal period as double-hulled tankers with segregated ballast water become more prevalent, but treatment of nonsegregated ballast water would continue until all tankers are double-hulled. A study by Ruiz and Hines (1997) found that nonsegregated ballast water contained very few viable organisms, possibly because of the toxicity of the hydrocarbons in the water. It is considered unlikely that nonindigenous organisms would be introduced into Port Valdez as a result of releasing the water treated in the BWTF.

A preliminary essential fish habitat (EFH) assessment indicates that alteration or loss of habitat under the proposed action may result in short-term adverse effects to essential habitat for salmon, scallops, and Gulf of Alaska groundfish. However, the effects are expected to be adequately minimized and mitigated by conservation measures associated with the proposed action such that there would be no significant adverse effects to EFH.

4.3.16.2 Impacts of Obstruction of Fish Passage

Obstructions to fish movement are most likely to occur when culverts or low-water crossings are not properly sized or maintained (Gustafson 1977; Rockwell 1978; Elliott 1982). Movement can be obstructed at either high or low flow. Elliott (1982) investigated stream crossings and channel modifications in the Atigun River in 1980 and described a number of fish-passage problems associated with culvert placement and design. DenBeste and McCart (1984) concluded that most of the passage problems at pipeline crossings were from pipeline construction, with substantially fewer problems during pipeline operation. Vehicular traffic during periods of low water can cause rutting and accumulation of cobbles that interfere with fish passage. Low-water crossings and culvert crossings were recognized as a potential source of fish passage problems early in construction of TAPS (Gustafson 1977; Rockwell 1978) and continued to be an issue (SPCO 1999). A recent review of compliance with the requirements of state laws (Title 16), regulations, and Federal Grant Stipulation 2.5 (Fish and Wildlife) revealed that approximately 23 site-specific fish passage deficiencies were recorded in the JPO Compliance Monitoring Database over the 5-year period from 1997 to 2001. The JPO's final report concluded that corrective actions by APSC had resolved these 23 previously recorded fish passage deficiencies (Gnath 2001).

Under the proposed action, activities that could obstruct movements would continue to be reviewed under the ADF&G Title 16 and Fish Habitat Permit processes. In addition, APSC conducts a surveillance program along the pipeline, and identification of potential obstructions to fish movement is one aspect of that program. Effective use of these surveillance reviews has minimized, and should continue to minimize, obstructions to fish movement along the ROW (SPCO 1993, 1995).

Fish Movement

The proposed action could result in temporary impediments to fish movement in some streams, but long-term effects on fish populations are not anticipated.

Obstruction of fish movement or entrapment also can occur during water withdrawal or when project activities such as in-stream gravel mining causes surface flows to spread, go below the surface, or become isolated (Woodward-Clyde Consultants 1980; Elliott 1982). Such a loss of surface flow occurred in the Atigun River, where flow dropped into the buried pipeline trench (Elliott 1982). Entrapment occurs, either naturally or due to human alterations, where decreasing flow strands fish in isolated pools. These pools can then dry out, become too warm to support fish, or freeze during winter (Woodward-Clyde Consultants 1980; Elliott 1982; DenBeste and McCart 1984). These problems were recognized either during the construction phase or early in operation and have been addressed with subsequent permitting and monitoring. Under Alaska Statute 16.05.870, permits from ADF&G are required for all activities below the ordinary high water line in anadromous fish waters. Excavation activities below the ordinary high water line in nonanadromous fish streams must be evaluated by ADF&G to determine if a

Title 16 permit is required, pursuant to AS 16.05.840 (APSC 1998a). Because of the review and permitting process, obstruction of movement and entrapment are not expected to persist over multiple seasons and should not result in significant impacts to fish populations in streams or rivers along the ROW.

Another potential cause of entrapment is the attraction of fish to water heated by the pipeline. In some areas, the buried pipeline heats subsurface water, the water emerges at a higher temperature than the receiving water, and fish are attracted to the warmer water as they search for overwintering areas (DenBeste and McCart 1984). Mortality occurs when water subsequently freezes or becomes anoxic. Water temperature problems resulting from the buried pipeline have been identified in the Atigun, North Fork Chandalar, Dietrich, and Middle Fork Koyukuk Rivers. DenBeste and McCart (1984) concluded that small numbers of fish were being lost in those streams where instream pipeline burial caused such temperature problems. Lower throughputs of oil in the future would result in reduced thermal effects because oil temperatures in the pipeline would be lower. Under the proposed action, these impacts to fish are expected to be minor because thermal effects occur in limited areas and because only small numbers of fish are likely to be affected.

A preliminary EFH assessment indicates that obstruction of fish passage under the proposed action may result in short-term adverse effects on essential habitat for salmon. However, the effects are expected to be adequately minimized and mitigated by conservation measures associated with the proposed action such that there will be no significant adverse effects to EFH.

4.3.16.3 Impacts of Increased Human Access

The increased access to remote areas provided by the ROW and access roads could potentially lead to increased harvest of fish in some locations. Prior to construction of TAPS, concern was expressed that such access might lead to excessive fish harvest (USFWS 1970). Overharvest can occur when access is provided to desirable resources and fishing regulations and enforcement do not adequately control harvest. BLM and USACE (1988) reported that in areas accessible to anglers, individual fish of the species preferred for harvest were smaller and less numerous than before construction of the TAPS Haul Road (now Dalton Highway). Because stream productivity is lower in northern areas than in southern areas, fish populations on the North Slope are likely to be more susceptible to impacts from excessive harvest than those in other regions of the state. Although such impacts may be important to stocks of fish in the immediate vicinity of access areas, they are not expected to be significant relative to nonanadromous fish populations as a whole in water bodies crossed by or adjacent to the TAPS ROW. Although a large increase in fishing effort and catch of Arctic char, Arctic grayling, and lake trout was expected when the entire length of the Dalton Highway was opened to the public in 1994, estimates from the annual Statewide Harvest Surveys do not indicate that this had happened on the North Slope (Burr 2001). In streams where anadromous fish migrate past access points, there is a potential for overharvesting to adversely impact anadromous fish populations. Maintenance of fish of desired sizes and at desired population levels has been largely accomplished by regulations established by the Board of Fish and enforced by the ADF&G. Consequently, the impacts of increased access to fish populations are expected to be minor. No adverse effects to EFH for salmon, scallops, or Gulf of Alaska groundfish from increased human access are expected under the proposed action.

4.3.17 Birds and Terrestrial Mammals

An overview of potential environmental changes associated with the proposed action that could affect wildlife is presented in Section 4.3.14. Undesirable consequences of any right-of-way corridor, such as that for the pipeline, can include adverse effects on hydrology and geomorphic features, habitat fragmentation, increased predation, road kills, invasion by nonnative species, increased spreading of diseases, degraded water quality and chemical contamination, degraded aquatic habitat, destructive human actions (e.g., poaching, fires, dumping), loss of soil productivity, and declines in biodiversity (Gucinski et al. 2001). Those changes most likely to affect wildlife include (1) habitat loss, alteration, or enhancement; (2) disturbance and/or displacement; (3) mortality; and (4) obstruction to movement. These impacts can result in changes in habitat use, changes in behavior, collisions with structures or vehicles, changes in predator populations, and chronic or acute toxicity from hydrocarbons and other compounds related to oil spills (see Section 4.4.4.11).

Impacts of Proposed Action on Birds and Terrestrial Mammals

Potential impacts to birds and terrestrial mammals associated with routine operation, maintenance, and monitoring of the TAPS include habitat loss, alteration, or enhancement; disturbance and/or displacement; mortality; and obstruction to movement. These impacts would essentially be a continuation of those currently associated with the TAPS. Impacts would be localized (e.g., usually to the immediate area of activity, although temporary avoidance responses may extend to 0.6 mi). Only individual animals would be impacted; no adverse impacts to populations of a species would be expected.

4.3.17.1 Habitat Loss, Alteration, or Enhancement

The direct and indirect effects from the existence and normal operation of the TAPS would include the habitat losses and modifications from maintenance activities; changes in habitat use caused by dust, impoundments, water quality impacts, or other habitat modifications; behavioral disturbance from noise and human activities; attraction or aversion to project facilities; wildlife injuries and mortality; and species-specific reductions or increases in productivity (Ritchie and Anderson 1997). Effects on wildlife from habitat loss or modification, discharges, and disturbance are expected to be minor at the population level and may not be detectable above natural population fluctuations (ADNR 2000; MMS 1998).

Generally, wildlife impacts associated with facility existence would occur from monitoring and maintenance over the next 30 years. Construction of the TAPS and monitoring and maintenance over the past 30 years have resulted in the current affected environment for birds and terrestrial mammals, as described in Sections 3.20 and 3.21. Impacts to wildlife have occurred primarily from the elimination and modification of habitats within the ROW, access roads, pump stations, Valdez Marine Terminal, and associated facilities (e.g., camps, airfields, and material sites). Habitat modification has resulted in both beneficial and adverse impacts to certain species. Wildlife species that would continue to be adversely affected by the existence of the TAPS are those that are most dependent on forests within the interior. Species preferring edge, shrub, willows, old-field or grassland habitats will continue to benefit from the existence of the TAPS. Some species may experience both beneficial and adverse impacts. For example, although the impoundments created by roads and workpads have provided nesting habitat for the Pacific loon, roads may prevent movement of loon families between wetlands, limiting their access to adequate food supplies (Kertell 2000).

With certain exceptions, areas lacking vegetation (e.g., workpad, access roads, active portions of quarries, river spurs, and river training structures) provide minimal habitat. Gravel roads and pads within the North Slope have reduced grazing habitat for caribou, but have provided insect-relief habitat (MMS 1998). Ground squirrels occupy previously unavailable areas and den in gravel fill within the oil fields (Shideler and Hechtel 2000). While gravel placement has resulted in habitat loss for most shorebirds, a few species, such as the semipalmated plover, that frequent natural gravel habitats, make use of the gravel pads and roads. Other shorebirds may roost or display from the elevated gravel surfaces (Troy 2000). Foxes have been known to use culverts and other construction materials for denning sites (ADNR 1999). Beavers dam culverts and occupy other areas where flowing water is diverted around TAPS infrastructure.

Periodic brush cutting of the ROW, which occurs primarily in forested areas, maintains those sections of the ROW in an early stage of plant community succession. Such vegetation management could benefit small mammals that use early successional habitats (e.g., hares) and their predators (e.g., lynx). Temporary increases in growth of willows following brush cutting benefits moose and other species that use willows (Wilson 2002). However, habitat maintenance can have localized adverse effects on species such as red squirrels, red-backed voles, and marten that prefer late-successional or forested habitats.

A corridor such as the TAPS ROW provides a specialized early succession habitat for certain species and travel lanes that enhance species' movements; however, it also presents barriers to movement for other species. The edges provided by rights-of-way (especially in forested areas) can be areas of relatively high biological productivity. Medium-sized predators concentrate within edges because of the increased availability of prey there (Williams 1995). Furthermore, the TAPS ROW can increase the browse available to ungulates (hooved animals such as moose and caribou) (Lunseth 1987).

Dust fallout is a common occurrence along the Dalton Highway. In areas of heavy dusting, vegetation can be eliminated within 70 ft of the road (TAPS Owners 2001a). Thermokarst has also been noted within 80 ft of a road (Troy 2000). In areas farther from the road or adjacent to less traveled dirt roads, the effects of dust fallout are early snowmelt and vegetation greening in spring, making such areas attractive to many herbivorous animals and, consequently, their predators (see TAPS Owners 2001a). Dust effects occur within less than 1.0 mi, with most effects concentrated within 300 ft of the roadway (MMS 1996b), except in the areas where dust deposition may blanket the vegetation. Waterfowl can benefit from both early open water and the early season food-plant growth in dust deposition areas (Section 4.3.15) (MMS 1998; Brown 2002). Often, roadside ditches provide the only open water areas during spring and, as such, attract birds (Anderson 2002). Heat from the buried portions of the pipeline can also provide similar benefits to waterfowl and other wildlife.

Most maintenance activities can occur on or along the workpad, so only minimal changes to wildlife habitat are expected under the proposed action. Nevertheless, some temporary losses of habitats along the TAPS would occur from ground-impacting activities (primarily trenching). Excavation, gravel placement, and other earthwork would normally alter small areas, primarily affecting small mammals such as shrews, voles, lemmings, and squirrels inhabiting those sites. Given the relatively small area that would be covered by newly placed gravel, the direct effects on wildlife populations of gravel placement are expected to be minimal.

4.3.17.2 Disturbance and Displacement

With normal operations of the TAPS, animals would continue to be disturbed by aircraft, trucks, snow machines, off-road vehicles, foot traffic, excavation equipment, and facility machinery. The response of wildlife to this disturbance is highly variable and depends on species; physiological or reproductive condition; distance; and type, intensity, and duration of disturbance (MMS 1995). In some areas, disturbance may affect selection of den sites by species such as bear and fox or displace animals from their dens. Wildlife can respond to disturbance in various ways, including attraction, habituation, and avoidance (Knight and Cole 1991).

Use of the TAPS ROW by snowmachines and ATVs may disturb and cause temporary displacement of some individuals. This activity has the potential to disturb denning animals on the ROW and in locations where these vehicles leave the ROW to access other areas. The entire ROW is used extensively for snow machine and ATV access in recreational activities, mining, trapping, and subsistence hunting (Schmidt 1999; Trudgen 1999).

Habituation to the TAPS and oil field facilities has been documented for a number of species. Moose acclimate to certain levels of disturbance over time, and the overall effects of normal operations are not expected to adversely affect moose populations (ADNR 2000). Sopuck and Vernam (1986b) found that the distribution and local movements of moose were not significantly affected by the TAPS near Big Delta. Repeated exposure to human activities over a large area of summer range has lead to some acclimation by caribou of the Central Arctic herd (Cronin et al. 1994). Nevertheless, for the 2-week period during calving, some cows with calves will avoid an area up to 0.6 mi around roads and facilities (Ballard and Whitlaw 2002). Additionally, the Prudhoe Bay oil field is a very wet area that is not an ideal area for calving. Therefore, there is no evidence that the area was ever used by a large number of caribou during calving (Cronin et al. 1998b). The Nelchina caribou herd (see Figure 3.21-2) continues to migrate along traditional routes despite the presence of the TAPS (Carruthers and Jakimchuk 1987). There is no evidence that populations of Dall sheep, musk ox, bison, or moose have been displaced as a result of the operation and maintenance of the TAPS (DuBois and Rogers 1999; Reynolds 1998; Eide et al. 1986; Jakimchuk et al. 1984), but such impacts can be difficult to detect (Chardine and Mendenhall 1998).

Bears, wolves, foxes, and squirrels are readily habituated and even attracted to human activities, primarily when a food source is accidentally or deliberately made available (Milke 1977; Follmann et al. 1980). Human food wastes and other attractants in developed areas can increase the populations of foxes, gulls, ravens, and brown bears, which in turn prey on waterfowl and other birds (Johnson 2000a,b; Ritchie and King 2000; Sedinger and Stickney 2000). It has been suggested that efforts to minimize impacts of predators may have greater benefits to wildlife populations in oil fields than would efforts to minimize habitat loss (Troy 2000).

Regular or periodic disturbance at TAPS facilities could cause adjacent habitats to be less attractive to wildlife and result in a long-term reduction of wildlife use in areas exposed to a repeated variety of visual disturbances and noise. A study of the effects of increased noise at the Central Compressor Plant in the Prudhoe Bay oil field found that spectacled eiders and pre-nesting Canada geese avoided habitats near noise sources. However, most species, including nesting Canada geese and brood-rearing brant, often habituate to these noises (Anderson et al. 1992). Brown bears generally avoid areas within about 300 ft of roads (McLellan and Sharkleton 1988); although evidence that bears avoid roads in the TAPS and Prudhoe Bay areas is lacking (Ballard and Whitlaw 2002).

Displaced animals could have lower reproductive success if they would be displaced to areas already occupied by others of their species (Riffell et al. 1996). However, it has not been demonstrated that animals within the North Slope are at their carrying capacity (Troy and Carpenter 1990). Thus, considering other population limiting factors, displacement does not seem likely to become a limiting factor (Brown 2002). If birds are disturbed sufficiently during the nesting season to cause displacement, then nest or brood abandonment might occur and the eggs and young of displaced birds would be more susceptible to cold or predators. However, no population-level effects to any wildlife species related to oil field developments, including the TAPS, have been demonstrated.

Caribou can be disturbed by snow machines and other moving vehicles (Tyler 1991; Horejsi 1981). Individual caribou generally hesitate before crossing under an elevated pipeline and may postpone crossing a pipeline and road for several minutes or hours during periods of heavy road traffic. Nevertheless, successful road crossings do occur (MMS 1998). Disturbance of individual caribou could cause (1) energetic stress resulting from displacement and (2) increased exposure to predators. In general, caribou can habituate to structures, noise, or odors. However, this generality does not apply to female caribou with newborn calves within 0.6 mi of roads or facilities, as previously mentioned. Also, all caribou habituate slowly or not at all to people on foot or to large moving objects (Murphy and Lawhead 2000). Regardless of potential impacts to individual caribou, the Central Arctic caribou herd has grown since its documented concurrence with oil field development (e.g., from about 5,000 in 1978 to more than 27,000 in 2000) (TAPS

Owners 2001a; Lenart 2000). Traditional knowledge viewpoints on the potential effects of the TAPS (and oil field development) on caribou movements are presented in Section 3.24 and are also addressed in Section 4.3.20.

Disturbance also can result from regular helicopter surveillance and other flights along the TAPS ROW. The effects of aircraft on wildlife vary among species, populations, environmental variables, and habitat types (TAPS Owners 2001a). Disturbance is greater from helicopters than from fixed-wing aircraft at similar distances (Watson 1993). The response of brown bears to helicopters and fixed-wing aircraft depends on the degree of habituation, availability of cover, and aircraft flight characteristics (Harting 1987). Animals that live near airports or other continuous sources of aircraft disturbance appear to become habituated (TAPS Owners 2001a). On the other hand, when brant are molting (losing feathers) they can be disturbed by helicopter takeoffs and landings at distances up to 1.7 mi (MMS 1996). If aircraft overflights are infrequent and of short duration, long-term displacement or abandonment of nesting, molting, or foraging areas is unlikely (MMS 1998). Generally, routine overflights by surveillance aircraft would only temporarily disturb animals along or near the ROW. Such disturbances would constitute a minor impact to animals residing in those areas, provided that deliberate harassment did not occur. Flight distance restrictions apply near zones of restricted access (ZRAs) to protect peregrine falcons and other nesting raptors (e.g., Franklin Bluffs Peregrine Falcon ZRA and Sagwon Bluffs Peregrine Falcon ZRA [APSC 1993]).

The effects on caribou from disturbance by helicopter and light fixed-wing aircraft have been studied extensively (see TAPS Owners 2001a). Responses of caribou to aircraft disturbance depend on season, activity before overflights, and habituation (Valkenburg and Davis 1984). Low-flying aircraft, fast-moving ground vehicles, and construction activities can disturb caribou. Responses can vary from no reaction to panic behavior. Cow and calf groups appear to be most sensitive (MMS 1998). Panic behavior can occur when aircraft fly within 1,000 ft (Calef et al. 1976). This response occurred when the aircraft circled and repeatedly flew over caribou groups. Disturbance from a single pass of an aircraft is expected to be brief, lasting a few minutes to one hour. These short-term disturbances should not affect caribou herd distribution or abundance (MMS 1998).

Most studies reported a fixed-wing tolerance threshold of 200 ft, below which panic and escape responses in individual caribou were apparent. Above 500 ft, reactions were rarely observed (see McKechnie and Gladwin 1993). As with most other terrestrial mammals, responses elicited in caribou by helicopter disturbances are greater than those from light fixed-wing planes. The tolerance threshold for helicopters was estimated to be 1,000 ft in altitude (Miller and Gunn 1979).

Reynolds (1998) cautioned that because musk ox are present on the Arctic Coastal Plain year-round and are limited by winter weather and food availability, they are vulnerable to human activities and should be avoided before, during, and after calving (April to mid-June). Energetic costs associated with forced movements of musk ox in winter from disturbance could be as significant as disturbance impacts during the calving season (ADNR 1999).

Brush cutting along the TAPS ROW would cause short-term disturbance of wildlife in the immediate vicinity of such activities. Animals that inhabit shrubs in the ROW would be displaced to adjacent undisturbed habitats. The relatively low frequency of this activity (once every few years, depending on the rate of vegetation growth) would reduce the severity of the impact. Avoidance of brush cutting in the early summer nesting period would further reduce these impacts to birds.

4.3.17.3 Mortality

The presence of TAPS facilities (e.g., pump stations, elevated portions of the pipeline, and the Valdez Marine Terminal) creates a physical hazard for some wildlife. For example, birds can collide with buildings during flight, and mammals may collide with fences. However, collisions of birds and mammals with TAPS facilities are infrequent (TAPS Owners 2001a).

The killing of nuisance bears and wolves has not been identified as a significant limiting factor for populations of these mammals in the vicinity of the ROW. With improved garbage management by APSC, enforcement of the animal feeding policy, public awareness programs, personnel training, and implementation of bear and nuisance wildlife plans, the incidence of killing nuisance animals as a part of TAPS operation is not expected to increase and might actually decrease over the 30-year renewal period. However, as the number of people continues to increase in all areas of the state, concerns for human safety will continue to be the main factor in nonhunting mortality of bears and wolves. In particular, with more frequent recreational use of remote areas accessible from the Dalton Highway (BLM 1998), mortality of brown bears may increase.

Legal and illegal take by hunters and trappers who use the ROW and access roads will constitute one of the impacts associated with continued operation of the TAPS system on gamebirds (e.g., waterfowl and ptarmigan) and furbearers (BLM 1998; TAPS Owners 2001a). These losses of game species could adversely affect predators, such as raptors, by decreasing the prey base (BLM 1998). However, hunting management regulations are designed to prevent serious impacts on populations. Hunter access will be available with or without ROW renewal. There is no evidence demonstrating whether increased access associated with the TAPS ROW has had an effect on wildlife populations (see also Sections 4.3.20 and 4.3.24.1) (TAPS Owners 2001a).

Vehicle use associated with normal operations (e.g., during transport of goods, monitoring, or commutes of workers to maintenance sites) could also affect wildlife. Collision with vehicles can be a source of mortality, especially in wildlife concentration areas or travel corridors. Increased traffic volumes result from increased human population and improved access. As the Dalton Highway increases in recreational value and its use is advertised and encouraged (BLM 1998), traffic volumes may increase. Concentrations of wildlife occur near the highway during spring snowmelt, and the numbers of roadkills increase during that period (Brown 1999; Shoulders 1999). Public use of access roads is very restricted, so roadkills on these roads would be extremely low. From a wildlife population perspective, roadkills do not result in a significant impact.

4.3.17.4 Obstruction to Movement

Continued operation of the TAPS would maintain a cleared ROW that may hinder or prevent movements of some small mammals. In particular, species preferring heavy cover in forested areas may be adversely affected (Oxley et al. 1974; Forman and Alexander 1998). Caribou, moose, Dall sheep, and bison encounter the pipeline and associated roads during seasonal migrations. The pipeline and associated facilities have become established components of the annual home range for nonmigratory populations. The degree to which roads serve as barriers to the movements of terrestrial mammals depends on traffic volume and speed, roadside vegetation, traditional movement patterns, and environmental factors motivating animal movement (e.g., insect harassment, predator avoidance) (Curatolo and Murphy 1986; Cronin et al. 1994).

In general, the ROW and the Dalton Highway are not barriers to movements of terrestrial mammals. However, there is evidence of deflected or delayed movements of individual moose and caribou. These occurrences are not regular, and no data indicate adverse effects at the population level (TAPS Owners 2001a). Caribou cows with new calves are wary of potential predators and may distance themselves from roads with traffic. Studies in the Milne Point oil field indicated that on the basis of a homogenous distribution, statistically fewer than expected numbers of calves were located closer than 0.06 mi from a road with traffic (Cameron et al. 1992). However, there were some calves within 0.6 mi, and all of the pregnant cows had to cross roads and pipelines to get into the study area (TAPS Owners 2001a).

4.3.18 Threatened, Endangered, and Protected Species

Six species that are federally listed as threatened, endangered, or depleted occur in the vicinity of the TAPS and may be affected by the proposed action. However, no designated critical habitat occurs in the vicinity of the TAPS. The spectacled eider and Steller's eider occur in the northernmost portions of the ROW. Both eiders are federally listed under the ESA as threatened and are considered species of special concern by the state. The fin whale, humpback whale, and Steller sea lion occur in Prince William Sound at the southern terminus of the TAPS and are listed under the ESA as endangered and under the MMPA as depleted. The humpback whale is state-listed as endangered, and the Steller sea lion is considered a species of special concern by the state. The beluga whale may occasionally occur in Prince William Sound in the winter; these animals are from the Cook Inlet stock, which is listed under the MMPA as depleted.

Impacts of Proposed Action on Threatened, Endangered, and Protected Species

Impacts to listed and protected species that may result from the proposed action would be within the range of those experienced over the past 25 years of TAPS operations. Impacts may result from ground disturbing activities, operational noise, human disturbance, and release of effluents from the Valdez Marine Terminal into Prince William Sound. Impacts are not expected to produce population-level effects that are distinguishable from natural variation in numbers.

Although the proposed action may result in some impacts to all of these species (see Table 4.3-5), the impacts are not expected to produce population-level effects that are distinguishable from natural variation in numbers. None of the listed and protected species that occur within the Beaufort Sea would be affected by the proposed action because TAPS operation does not directly or indirectly affect the waters of the Beaufort Sea.

Several other listed or protected species occur in the vicinity of TAPS and also may be affected by the proposed action. Potential impacts to these species also are summarized in Table 4.3-5. The Eskimo curlew, federally and state-listed as endangered, formerly nested in habitat crossed by the ROW, but it has not been observed in the wild for decades and may be extinct. Two formerly listed species — American peregrine falcon and Arctic peregrine falcon — nest along the ROW. Four species of songbirds — olive-sided flycatcher, gray-cheeked thrush, Townsend's warbler, and blackpoll warbler — are considered species of special concern by the state and could occur along the ROW. Eight species of marine mammals occur in Prince William Sound and are protected but not considered depleted under the MMPA. These species include the gray whale, minke whale, killer whale, Pacific white-sided dolphin, harbor porpoise, Dall's porpoise, harbor seal, and sea otter. No other species occurring in the vicinity of the TAPS are candidates or proposed for federal or state listing.

4.3.18.1 Impacts to Spectacled and Steller's Eiders

Both the spectacled eider and Steller's eider breed along the coast of the Beaufort Sea and in adjacent wetlands and ponds of the Arctic Coastal Plain. The portion of the TAPS ROW that crosses through habitat of these species is between MP 0 and 40. The number of spectacled eiders in the vicinity of the TAPS is relatively low compared with the numbers of other portions of the species' summer range, and although Steller's eider habitat exists in the project area, none have been observed there (see Section 3.22.1). Overall, the potential for interaction between these species and TAPS infrastructure and operations is relatively low because of the distribution and density of populations in the project area. The relatively low density of eiders in the TAPS vicinity has not been attributed to human disturbance or developments, and these species exist in relatively high densities in other portions of North Slope oil fields where levels of development and

TABLE 4.3-5 Potential Impacts of the Proposed Action on Threatened, Endangered, and Protected Species

Species	Status[a]	Time of Year	Locations	Potential Impacts
Spectacled eider	ESA-T AK-SC	May - Sept.	Wetlands and ponds of Arctic Coastal Plain (MP 0–40)	Potential disturbance in immediate vicinity of ROW resulting from noise and human activity associated with monitoring and maintenance activities and PS 1 operations. Ground-disturbing activities could affect nesting habitat if water or sediment is discharged into nesting habitat.
Steller's eider	ESA-T AK-SC	May - Sept. along ROW; winter in Prince William Sound	Wetlands and ponds of Arctic Coastal Plain (MP 0–40); Prince William Sound	Same as previous along ROW. In Prince William Sound, effluent discharged from Valdez Marine Terminal Ballast Water Treatment Facility and sanitary wastewater treatment plant would be monitored and kept within permitted levels.
Eskimo curlew	ESA-E AK-E	NA[b]	NA	No impacts anticipated because species probably extinct. Previously nested in arctic tundra of Alaska and Canada.
American peregrine falcon	ESA-DM AK-SC	April - Sept.	Near rivers and lakes south of Brooks Range (MP 240–800)	Potential disturbance in immediate vicinity of ROW resulting from noise and human activity associated with monitoring and maintenance activities and pump station operations.
Arctic peregrine falcon	ESA-DM AK-SC	April - Oct.	Near Sagavanirktok River (MP 0–110)	Same as previous.
Olive-sided flycatcher	AK-SC	April - Oct.	Coniferous forest south of Brooks Range (MP 240–800)	Same as previous.
Gray-cheeked thrush	AK-SC	May - Oct.	Coniferous and mixed forest south of Brooks Range (MP 240–800)	Same as previous.
Townsend's warbler	AK-SC	April - Oct.	Coniferous forest in Yukon River valley (MP 330–380) and southern Alaska (MP 540–800)	Same as previous.
Blackpoll warbler	AK-SC	April - Oct.	Coniferous and mixed forest south of Brooks Range (MP 240–800)	Same as previous.

TABLE 4.3-5 (Cont.)

Species	Status[a]	Time of Year	Locations	Potential Impacts
Gray whale	ESA-D MMPA-P	Late spring and early fall	Prince William Sound	Effluent discharged from Valdez Marine Terminal Ballast Water Treatment Facility and sanitary wastewater treatment plant to Prince William Sound would be monitored and kept within permitted levels.
Fin whale	ESA-E MMPA-D	April - June	Prince William Sound	Same as previous.
Beluga whale	MMPA-D	Winter	Prince William Sound	Same as previous.
Minke whale	MMPA-P	Summer	Prince William Sound	Same as previous.
Humpback whale	ESA-E MMPA-D AK-E	Summer	Prince William Sound	Same as previous.
Killer whale	MMPA-P	All year	Prince William Sound	Same as previous.
Pacific white-sided dolphin	MMPA-P	All year	Prince William Sound	Same as previous.
Harbor porpoise	MMPA-P	All year	Prince William Sound	Same as previous.
Dall’s porpoise	MMPA-P	All year	Prince William Sound	Same as previous.
Steller sea lion	ESA-E MMPA-D AK-SC	All year	Prince William Sound	Same as previous.
Harbor seal	MMPA-P	All year	Prince William Sound	Same as previous.
Sea otter	MMPA-P	All year	Prince William Sound	Same as previous.

[a] Notation: ESA = listed under the Endangered Species Act with the following qualifiers: E = endangered, T = threatened, D = delisted, DM = delisted but being monitored; AK-SC = Alaska species of special concern; MMPA = listed under the Marine Mammal Protection Act, with the following qualifiers: D = depleted, P = protected.

[b] NA = not applicable.

activity are comparable or even higher (Anderson et al. 1992; TERA 1995, 1996; Warnock and Troy 1992).

The proposed action may affect individuals of either eider species in several ways. Human activity associated with normal operations, monitoring, and maintenance would occur regularly throughout the 30-year renewal period along the ROW and in the vicinity of PS 1. This activity and the noise generated by equipment have the potential to disturb eiders, especially during nesting. In addition, any ground-disturbing activities needed to repair the pipeline, workpad, or associated facilities could affect habitat if water or sediment was discharged into nesting habitat. As discussed below, there is no indication that the proposed action would affect populations of either the spectacled or Steller's eider.

Human activities would occur along the TAPS on a daily basis under the proposed action as a consequence of normal operations, monitoring, maintenance, and surveillance. Additionally, the presence of the TAPS and the Dalton Highway would continue to support increased human activity on the North Slope. Eiders appear to be attracted to roadside areas prior to nesting, when these areas are largely snow free and many are flooded (Warnock and Troy 1992). Warnock and Troy (1992) reported slightly fewer than expected spectacled eiders within 800 ft of facilities on the North Slope, but this difference was not statistically significant. Helicopter overflights and other activities associated with TAPS monitoring and maintenance have the potential to disturb nesting eiders in the action area and may result in temporary displacement from nests or, potentially, nest abandonment. Human activities associated with normal operations, monitoring, maintenance, and surveillance are not likely to adversely affect either spectacled or Steller's eiders because so few eiders occur in the TAPS action area, and similar activities have occurred during the past 25 years of operations without apparent effects on either species.

Continuous noise would be generated by PS operations during the 30-year renewal period and has the potential to affect spectacled and Steller's eiders. Noise measurements have not been made in the vicinity, but the original TAPS EIS (BLM 1972) conservatively estimated that noise levels would be 74 dBA at 600 ft from the facility (see Section 3.14). Previous studies of the response of birds to continuous noise have reported habituation in some species but avoidance by others, especially during sensitive periods such as the nesting period (Manci et al. 1988; LaGory et al. 2001). However, pump station noise is not likely to adversely affect either spectacled or Steller's eiders because the density of eiders in the project area is so low. These facilities have operated for the past 25 years without apparent effects on either species.

Under the proposed action, periodic ground-disturbing activities may affect spectacled and Steller's eiders in the vicinity of TAPS. Most of these activities would occur within the ROW and be limited to the existing workpad, where impacts would be minimal. However, runoff from construction areas may affect adjacent habitats off the workpad. Spectacled eiders are known to preferentially use roadside impoundments (as occur along the workpad) during the pre-nesting and brood-rearing periods (Warnock and Troy 1992), and they may be affected by any degradation of these habitats caused by sedimentation. Erosion control practices are identified in the *Trans-Alaska Pipeline Maintenance and Repair Manual,* MR-48 (APSC 2001j) and would effectively minimize the potential for significant sedimentation effects.

Water that accumulates in excavations (e.g., corrosion-repair excavations) and in the secondary containment areas at pump stations is pumped out and discharged to adjacent areas. These discharges are governed by a state permit that requires notification, volume estimates, and descriptions of procedures to minimize erosion and discharge of pollutants (see Section 4.3.6). Consequently, these discharges are not likely to adversely affect eiders.

The proposed action is not expected to result in increased hunting pressure on either spectacled or Steller's eiders. Currently, little, if any, hunting occurs in the breeding areas of the North Slope, and no hunting is permitted in the Prudhoe Bay area (Warnock and Troy 1992). The ESA prohibits nonsubsistence hunting of either of these species anywhere within their range.

Human activities on the North Slope, particularly with regard to food waste management practices, have a potential to support increased populations of predators that feed on waterfowl eggs and young (USFWS 2002). Such predators, which include glaucous gulls, common ravens, grizzly bears, and Arctic foxes, are attracted to human food wastes. Predation may be the single most important factor affecting eider nesting success in some areas (USFWS 2002). The TAPS Environmental Protection Manual (APSC 1998b) includes a number of project requirements designed to eliminate or minimize this potential problem of predator attraction. These measures include improved solid-waste management (e.g., prompt and thorough incineration of garbage, complete enclosure of pump stations with fences, use of bear-proof garbage containers) and the prohibition of the feeding of wildlife and conducting other avoidable activities that may attract wildlife to work areas. Currently, all food wastes generated at PS 1, 2, and 3 are incinerated prior to disposal. Because of these requirements, TAPS ROW grant renewal is not expected to increase predator populations and, consequently, not likely to adversely affect either the spectacled or Steller's eider.

Normal Valdez Marine Terminal operations are not expected to adversely affect either the spectacled eider or Steller's eider. The spectacled eider does not occur in Prince William Sound, and Steller's eiders are occasionally found there only in winter and only outside of the action area. The listed Alaska-breeding population of Steller's eider intermixes with the more numerous and unlisted Russian Pacific population in marine waters of southwest Alaska. Thus, the listing status of Steller's eider near the action area is unknown. Water quality impacts from Valdez Marine Terminal effluent discharge to Port Valdez have not resulted in water quality degradation during the past 25 years of operations, and no such degradation is anticipated during the renewal period, when discharges will be substantially reduced. All discharges are regulated by an NPDES permit requiring that effluents be maintained within protective limits (see Section 4.3.8.1 for additional details). Normal Valdez Marine Terminal operations are not likely to adversely affect either the spectacled or Steller's eider.

4.3.18.2 Impacts to Fin Whale, Humpback Whale, Beluga Whale, and Steller Sea Lion

The fin whale, humpback whale, beluga whale, and Steller sea lion all occur in Prince William Sound at various times of the year. These species may be affected by normal operations under the proposed action if effluent discharged from the Valdez Marine Terminal Ballast Water Treatment Facility and sanitary wastewater treatment plant into Port Valdez resulted in water quality degradation of Prince William Sound. However, discharges from the Valdez Marine Terminal facilities are regulated under an NPDES permit that establishes limitations and a monitoring schedule for flow rate, biochemical oxygen demand, total suspended solids, pH, benzene, toluene, ethylbenzene, xylene, total aqueous hydrocarbons, dissolved inorganic phosphorous, ammonia, zinc, and whole effluent toxicity (see Table 3.11-1 in Section 3.11.1.1). Measured discharge levels have been well below permit requirements and can be expected to continue that way during the 30-year renewal period. In general, water quality within Prince William Sound is considered good, and impacts to these species are not expected to result from effluent discharge associated with normal operations under the proposed action.

4.3.18.3 Impacts to Other Species

A number of other protected species or species of concern exist along the ROW or occur in Prince William Sound (Table 4.3-5. The American peregrine falcon, Arctic peregrine falcon, olive-sided flycatcher, gray-cheeked thrush, Townsend's warbler, and blackpoll warbler occur in various habitats and locations along the ROW and may be disturbed by human activities associated with normal operations, monitoring, and maintenance. For the most part, however, these disturbances are expected to result in temporary displacement of individuals until disturbing activities in a specific location cease. Habitat modification associated with the proposed action would have little, if any, impact on these species because ground-disturbing activities generally would be limited to the ROW and previously disturbed areas. Any indirect effects to adjacent habitats resulting from erosion or sedimentation are unlikely to affect populations of these species. Noise generated by the continuously operating pump stations and other equipment may result in a reduction in the use of adjacent habitats by these species. No studies are available documenting the response of these species to disturbance from the TAPS, but any impacts are expected to be limited to the immediate project area, should be relatively minor over the 30-year renewal period, and should be within the range of impacts experienced over the past 25 years of operations. It should be noted that there is no indication that TAPS operations have affected any of these species.

The JPO, in conjunction with the USFWS, has designated five nesting and rearing areas used by peregrine falcons in the vicinity of the TAPS ROW as zones of restricted activity: (1) Franklin Bluffs on the east side of the Sagavanirktok River (MP 15–36); (2) Sagwon Bluffs on the east side of the Sagavanirktok River (MP 57–61 and 59–68); (3) Slope Mountain (MP 113–116); (4) Yukon River (MP 350–355); and (5) Grapefruit Rocks (MP 417–418) (APSC 1998b). This designation provides certain protective restrictions, including (1) restriction of aircraft and ground vehicle use in the areas during the nesting season (April 15 to August 5), (2) prohibition of the construction of permanent facilities, and (3) prohibition of the use of pesticides. These restrictions would serve to limit the impact of the proposed action on peregrine falcons.

Several species of protected marine mammals in addition to those discussed in Section 4.3.18.2 also occur in Prince William Sound. They are the gray whale, minke whale, killer whale, Pacific white-sided dolphin, harbor porpoise, Dall's porpoise, harbor seal, and sea otter. None of these species is considered rare or listed as depleted under the MMPA. Impacts may occur if discharges from Valdez Marine Terminal facilities resulted in degraded water quality in Prince William Sound. As discussed in Section 3.11.1.1, there is no indication that the water quality of Prince William Sound has been significantly degraded by Valdez Marine Terminal operations, and, consequently, normal operations over the 30-year renewal period should not have a measurable impact on any of these species.

4.3.19 Economics

Renewal of the Federal Grant and continued operation of the pipeline would impact the national economy, the state economy, and the regional economies along the pipeline corridor. These effects would include direct and indirect economic impacts of oil production and the pipeline operation itself at the three geographic scales. Section A.8 in Appendix A describes the methodology used to calculate these economic impacts. The impacts of pipeline renewal on Alaska Native corporations and subsistence activities are also included in this analysis. The economic impact of accidental oil spills from the pipeline are evaluated in Section 4.4.4.13. Potential impacts of accidents related to tanker transportation in Prince William Sound are included in the analysis of the cumulative impacts (Section 4.7).

Economic Impact Assessment

As described in Appendix A, Section A.8, the Man in the Arctic Program (MAP) computer model developed at the University of Alaska-Anchorage, Institute for Social and Economic Research, was used to assess potential economic impacts of future TAPS operations. The model uses three modules – an economic module, a demographic module, and a fiscal module – to evaluate possible impacts in those areas over the range of changing conditions being examined. The results are discussed here for the proposed action.

4.3.19.1 Assumptions Used in the Analysis

Various assumptions were required in order to conduct the economic impact analysis. Included were assumptions relating to pipeline operations, North Slope oil production, world oil prices, and other activities in the Alaskan economy, in particular key sectors that are important sources of potential future employment — namely the seafood, tourism, air cargo, and state and local government economic sectors. These assumptions are discussed in the following subsections.

4.3.19.1.1 Assumptions Relating to Oil Production, Prices, and Pipeline Transportation. The following assumptions were made relating to oil production, prices, and pipeline transportation:

- *North Slope oil production:* The analysis used forecasts of annual North Slope production published by the DOE's Energy Information Administration (DOE-EIA) (DOE 2001a). Those forecasts include anticipated production from oil fields currently producing oil, production from the anticipated development of identified fields, and production from technically recoverable but as yet undiscovered oil resources. Consideration of probabilities associated with production in each of these categories yields a bounding range of potential production in each year. For the purposes of analysis, the mean value was chosen for all potential production in these categories in each year of the renewal period. Included in the evaluation was production from existing producing and developing fields and the addition of oil from the Prudhoe Bay/Central Area in 2005, the Northeast NPR-A fields beginning in 2010, and the West-NPR-A in 2015. On the basis of this forecast, production levels are expected to increase slightly between 2000 and 2005, and then begin a steady decline throughout the remainder of the renewal period (Table 4.3-6).

TABLE 4.3-6 Projected North Slope Oil Production and World Crude Oil Prices

Year	North Slope Production[a] (10^6 bbl/d)	Oil Prices[b] (2000 $/bbl)
2000	1.045	28.22
2005	1.084	21.31
2010	0.961	21.86
2015	0.888	22.39
2020	0.723	22.93
2025	0.509	23.49
2030	0.315	24.05
2034	0.208	24.52

a Source DOE (2001a).

b Derived from the DOE's *Annual Energy Outlook* forecast (DOE 2001b). Prices are deflated by using the gross domestic product implicit price deflator (Bureau of Economic Analysis 2001).

- *World oil prices:* The analysis used world crude oil prices forecasted by DOE as part of the analysis of future oil production from North Slope (DOE 2001a). These forecasts show a drop in crude prices in real dollars over the period 2000-2005, after which prices slowly rise over the remainder of the renewal period (Table 4.3-6).

- *Pipeline operations:* Including operations, contract workers, and special project employment, it was assumed that there would be 1,828 workers operating the pipeline at the beginning of the renewal period. This number would fall to 1,716 in 2008, with declining throughput after 2005 and the closure of a number of pump stations, and remain steady at that level for the remainder of the renewal period (TAPS Owners 2001a).

- *Oil field development activities:* Oil exploration, development, and production in the North Slope fields would continue throughout the renewal period, with no activity assumed to occur in the ANWR. Employment in the oil fields would remain constant, as smaller, more labor-intensive fields replace larger, more productive fields. Development of North Slope gas resources was assumed to occur throughout the renewal period, but no specific projects, such as gas to liquids for transport in the TAPS or a separate gas pipeline, were included in the analysis.

- *Oil industry activities:* Manufacture of oil field equipment and supplies would continue throughout the renewal period, and refining of North Slope oil for the Alaska market would continue at prerenewal period levels.

- *Tanker transportation:* Declining TAPS throughput would gradually reduce the number of tankers needed to carry North Slope crude to West Coast ports, and the reduction in refined products from North Slope oil, also as a result of declining throughput, would gradually increase the demand for imported refined petroleum products from outside the state.

- *Government oversight:* Employment in government oversight activities was assumed to be constant throughout the renewal period.

4.3.19.1.2 Assumptions Relating to Other Activities in the Alaskan Economy. Assumptions made concerning other economic activities in the state were as follows:

- *Key sectors:* Activities in Alaskan economic sectors with employment growth potential, in particular seafood processing, tourism, and air cargo, would continue to grow on average throughout the renewal period. Growth trends in seafood, however, can be cyclical, and tourism and air cargo make only small contributions to overall economic activity in the state. Federal and state government employment would remain relatively stable, and military employment would remain constant throughout the period.

- *State and local government finances:* Declining petroleum revenues with declining production, as assumed above, would mean that additional sources of funds would be needed by the state to cover slowly increasing General Fund expenditures at the state and local levels. The analysis assumed that the deficit would be covered entirely with cash reserves from the Constitutional Budget Reserve Fund through 2004. A sales tax, reinstitution of a state personal income tax, a cap on the Permanent Fund Dividend, changes in petroleum sector tax rates, reductions in state and local expenditures, and the use of some portion of the earnings of the Permanent Fund are all being considered by the state legislature to cover increasing deficits. While a number of these measures, notably a personal income tax and the use of some portion of the earnings from the Permanent Fund, have already been proposed by various parties to address current state budgetary problems, this analysis does not include any of these options because of the uncertainty surrounding the likely use and timing of any particular fiscal policy option. The selection of any one, or combination, of policy options to address the budget deficit was considered to be beyond the scope of the analysis.

4.3.19.2 National Economic Impacts

The economic impacts of renewing the Federal Grant and continued pipeline operation on the national economy would include the impact on domestic oil production and national energy security, balance of trade, federal tax revenues, marine transportation, and the overall impact on economic activity in the United States. In general, the impacts of continued TAPS operation would be greater at the beginning of the renewal period, with impacts closely related to the level of TAPS throughput. Throughput is forecast to remain steady at the beginning of the period but start to decline after 2005 and continue to decline throughout the remainder of the renewal period (see Table 4.3-6).

4.3.19.2.1 Domestic Oil Production and National Energy Security. Continued operation of the TAPS and the North Slope fields through the year 2034 would contribute an estimated 8.9 billion bbl of crude oil to U.S. domestic production over the

Impacts of Proposed Action on U.S. Domestic Oil Production, Energy Security, Balance of Trade, and Federal Tax Revenues

North Slope oil production would make a substantial, although declining, contribution to domestic oil production and would continue to reduce the need for foreign oil imports, thus improving national energy security and the overall balance of trade. Significant federal tax revenues would be generated with continued TAPS operations, together with marine and shipbuilding employment and employment in the economy as a whole.

renewal period (DOE 2001a). While the contribution of North Slope crude to domestically produced oil supplies would decline from 18% in 2004 to 14% in 2020 (DOE 2001b) as a result of declining production, North Slope oil would still make a substantial contribution to the reduction of U.S. dependency on foreign oil supplies. Dependency on oil from outside the United States can create significant foreign policy issues if the countries supplying the oil are politically or economically unstable. North Slope oil would continue to contribute to the reduction of dependency on foreign oil.

4.3.19.2.2 Balance of Trade. The United States would continue to be a net importer of crude oil over the renewal period, with steady growth in domestic consumption and declining domestic production (DOE 2001b). On the basis of world oil price forecasts produced by the DOE for each year in the renewal period, North Slope production over the entire renewal period would be valued at $374 billion in 2000 dollars (DOE 2001b). Despite the worsening negative trade balance the United States has in oil, production from the North Slope over the renewal period would help to offset the increasing U.S. dependency on foreign oil, reducing oil imports from 9.9 million bbl/d to 8.8 million bbl/d, a reduction of 11%, in 2004, and from 11.2 million bbl/d to 10.5 million bbl/d, a reduction of 6%, in 2020 (DOE 2001b). In addition, when the cost of domestic oil production is less than the price of imported oil, there are benefits to U.S. consumers and to the federal government.

4.3.19.2.3 Federal Tax Revenues. Federal income taxes and royalties on federal lands related to the TAPS would generate significant tax revenues for the federal government over the renewal period. Over the entire 30-year renewal period, these revenues would reach an estimated $11.4 billion (in 2000 dollars) (ECA 1999a).

4.3.19.2.4 Marine Transportation. The current fleet of single-hulled tankers used to transport North Slope crude oil is being phased out in favor of double-hulled tankers under the stipulations of the Oil Pollution Act of 1990 covering the transportation of North Slope oil from Valdez to ports on the West Coast. Replacement of the single-hulled fleet, together with the projected decline in North Slope production, is expected to create a demand for an additional nine 125,000-ton tankers over the renewal period (ECA 1999b). Approximately $1.6 billion (in 2000 dollars) would be spent in U.S. shipyards to accommodate North Slope transportation demand. This level of activity would produce approximately 1,000 shipyard jobs per tanker (GAO 1999), with additional jobs created in the various industries supplying shipyards with equipment, materials, and services. Maintenance activities would also provide additional employment at shipyards. Marine transportation would also produce employment, but at declining levels as North Slope production declines. About 1,330 U.S. seamen would be required at the beginning of the renewal period, declining to 530 seamen by 2034 (TAPS Owners 2001a).

4.3.19.2.5 Overall Economic Activity. North Slope oil production has a much smaller impact on the U.S. economy as a whole than it does on the oil production and transportation sectors in the United States. Oil from the North Slope is priced at the prevailing world level for crude plus pipeline transportation costs. The difference in price between North Slope and non-North Slope oil at West Coast ports is small and is due primarily to differences in transportation costs, with the relatively short distance between Alaska and the West Coast only providing a minor advantage to North Slope oil producers. As a result, the price advantage to North Slope oil does not have a significant impact on input costs to West Coast refiners and subsequently on industries using North Slope-derived refinery products. With gradually declining North Slope production over the renewal period, replacement supplies for North Slope oil would have to be found for West Coast refineries and the industries purchasing their products. Assuming the widespread availability of suitable oil from other sources, either from U.S. production or from foreign suppliers, refinery production and refinery product customer industries would be able to continue with little or no impact on product prices or availability.

4.3.19.3 State Economic Impacts

The impacts of the proposed action on the economy of Alaska would include the impact on population (including net migration), gross state product, employment and unemployment, personal income, and state and local tax revenues. Population and economic impacts in the state were estimated using the MAP model. In general, the impacts of continuing TAPS operation would be greater at the beginning of the renewal period (see Figure 4.3-4), with impacts closely related to the level of TAPS throughput (see Table 4.3-6).

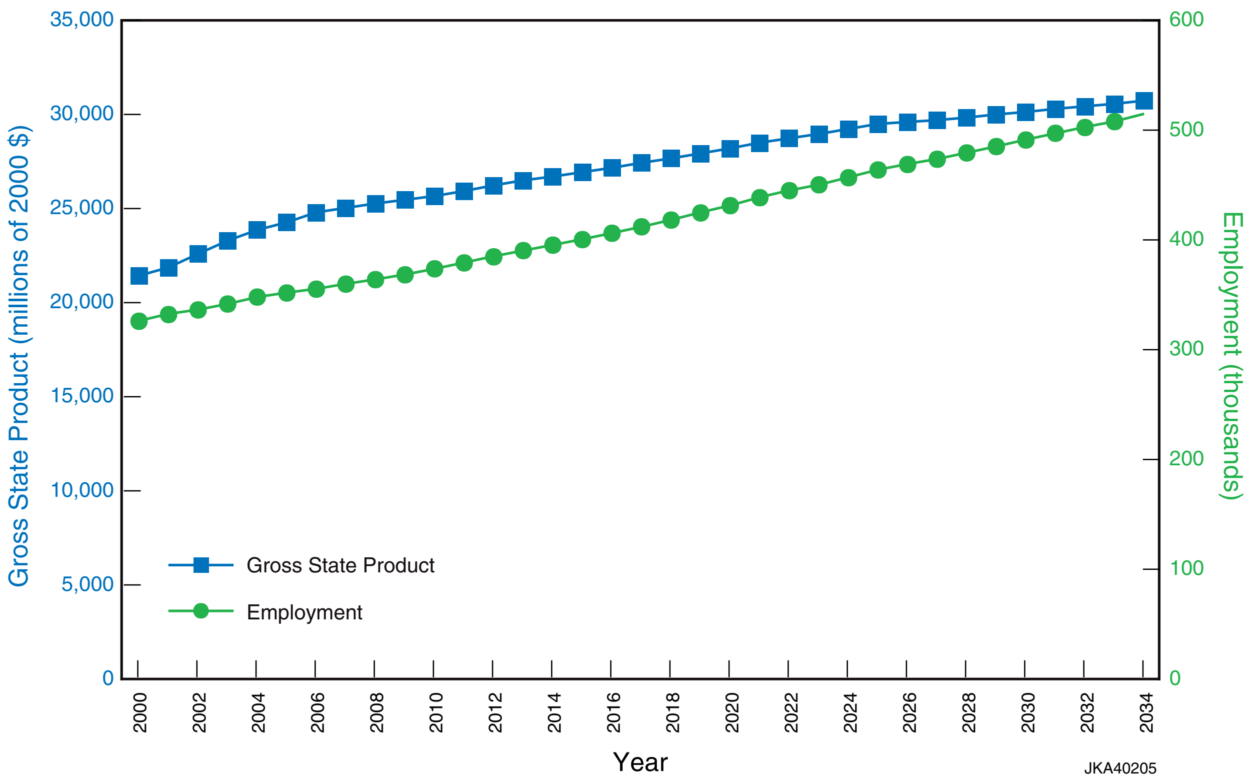

FIGURE 4.3-4 Alaska Gross State Product and Employment with Continued TAPS Operation

Impacts of Proposed Action on Population, Gross State Product, Employment, and Tax Revenues

Under the proposed action, North Slope oil production and the pipeline would continue to have a large impact on population, employment, incomes, and tax revenues in Alaska. While TAPS throughput is projected to begin a long decline starting in 2005 (meaning that the impact of the oil sector and supporting industries would diminish over the renewal period), population, gross state product, employment, and personal incomes are projected to increase slightly on average over the renewal period. Unemployment is also expected to increase slightly. The decline of state oil revenues would mean that the state would require additional sources of revenue to cover the moderate growth expected in expenditures at the state and local levels.

4.3.19.3.1 Population. With the renewal of the Federal Grant in 2004, population in the state would grow at a moderate annual average rate of 1.6% over the entire renewal period, with a slightly higher growth rate between 2004 and 2019 (Table 4.3-7). Growth in the Alaska Native population would be higher than in the non-Native population, with significant out-migration of non-Native population expected to occur, particularly between 2004 and 2019, as pipeline throughput, state tax revenues, and personal incomes fall.

4.3.19.3.2 Gross State Product. The GSP, the sum of value added in the production of all goods and services in a year, measures the level of economic activity in the state. Table 4.3-8 presents GSP in terms of constant dollars, which are used to exclude the effects of inflation in the economy and fluctuations in natural resource prices when comparing GSP over time. The GSP of Alaska, measured in constant 2000 dollars, would experience a moderate increase of 0.9% over the entire renewal period (2004 to 2034), with a slightly higher annual growth rate over the first 15 years of the period.

In individual industries, GSP growth would be concentrated among industries providing services, especially transportation; communication and public utilities, trade, finance and services; and tourism. Growth in these sectors would average between 1.7 and 2.0% per year, with slightly larger increases in financial services and tourism. Growth in transportation and, in particular, tourism would

TABLE 4.3-7 State Population Projections

Item	Population by Year				Average Annual Rate of Growth (%)		
	2003	2004	2019	2034	2004 to 2019	2019 to 2034	2004 to 2034
Alaska	667,863	681,565	881,875	1,099,363	1.7	1.5	1.6
Non-Native	505,745	516,542	663,437	800,772	1.7	1.3	1.5
Native	117,873	120,778	174,193	254,345	2.5	2.6	2.5
Military[a]	44,245	44,245	44,245	44,245	0.0	0.0	0.0
Net migration	6,547	7,290	6,635	3,870	-2.3	-7.6	-5.0
Net migration share (%)	1.0	1.1	0.8	0.4	-3.7	-8.9	-6.4

[a] Includes active duty military personnel and their dependents.

Source: MAP model (see Appendix A, Section A.8).

TABLE 4.3-8 Projected Alaska Gross State Product by Industry (millions of 2000 dollars)

	GSP by Year				Average Annual Rate of Growth (%)		
Industry	2003	2004	2019	2034	2004 to 2019	2019 to 2034	2004 to 2034
Alaska	23,310	23,877	27,934	30,743	1.1	0.6	0.9
Mining (including Oil and Gas)	3,521	3,626	4,095	4,134	0.8	0.1	0.4
Agriculture, Forestry and Fisheries	598	599	613	620	0.2	0.1	0.1
Construction	1,287	1,319	1,292	1,410	-0.1	0.6	0.2
Manufacturing	1,180	1,187	1,320	1,474	0.7	0.7	0.7
Transportation (including Air Cargo)[a]	2,849	2,916	3,881	4,853	1.9	1.5	1.7
Communications and Public Utilities	1,367	1,390	1,822	2,331	1.8	1.7	1.7
Wholesale and Retail Trade[a]	1,538	1,567	2,069	2,654	1.9	1.7	1.8
Finance	2,012	2,051	2,796	3,670	2.1	1.8	2.0
Services[a]	3,132	3,198	4,247	5,489	1.9	1.7	1.8
Tourism[a]	1,084	1,128	1,540	1,970	2.1	1.6	1.9
Federal Civilian	1,624	1,627	1,677	1,697	0.2	0.1	0.1
State Government	1,143	1,166	1,318	1,467	0.8	0.7	0.8
Local Government	1,688	1,730	1,945	2,220	0.8	0.9	0.8
Military	1,280	1,279	1,270	1,266	-0.1	0.0	0.0

[a] Tourism includes activity also included in Transportation, Trade, and Services. To avoid duplication, data in the tourism row are not included in the Alaska total.

Source: MAP Model (see Appendix A, Section A.8).

be markedly higher during the first 15 years of the TAPS renewal period. Transportation includes air cargo, which experienced high growth rates during the 1990s. The sector would be expected to continue to grow fairly rapidly until 2019 in response to market growth and the availability of competitively priced jet fuel refined inside the state, and would then remain stable throughout the remainder of the period. Tourism, helped historically by cheaper in-state petroleum fuel supplies (TAPS Owners 2001a), would experience higher than average annual growth in the first half of the renewal period based partly on cheaper fuel supplies at the beginning of the period. Other natural-resource-based industries, such as mining, forestry, and fishing, would experience much lower average growth rates than the average state rate, with better growth prospects during the first part of the renewal period.

The GSP related to federal government activity would remain relatively stable throughout the entire renewal period, with only 0.1% annual growth, while state and local activity would each produce annual increases of 0.8%. A slight decline in federal and state government GSP growth rate in the second half of the period would be in contrast to a slight increase in the local government GSP growth.

4.3.19.3.3 Employment and Unemployment. Total employment in Alaska would grow at an annual average rate of 1.3% over the entire renewal period (2004 to 2034) (Table 4.3-9). The state rate would be outpaced by a number of industries, including

TABLE 4.3-9 Projected Employment in Alaska by Industry

	Employment by Year				Average Annual Rate of Growth (%)		
Industry	2003	2004	2019	2034	2004 to 2019	2019 to 2034	2004 to 2034
Alaska	342,047	348,345	425,000	514,804	1.3	1.3	1.3
Mining (including Oil and Gas)	10,157	10,381	11,251	11,505	0.5	0.2	0.3
Agriculture, Forestry and Fisheries	1,991	2,011	2,370	2,546	1.1	0.5	0.8
Construction	15,818	16,275	16,297	18,135	0.0	0.7	0.4
Manufacturing	15,440	15,464	15,901	16,315	0.2	0.2	0.2
Transportation[a] (including Air Cargo)	20,893	21,376	28,321	35,286	1.9	1.5	1.7
Communications and Public Utilities	6,381	6,454	7,767	9,186	1.2	1.1	1.2
Wholesale and Retail Trade[a]	63,643	64,874	85,752	110,001	1.9	1.7	1.8
Finance	12,523	12,773	17,565	23,246	2.2	1.9	2.0
Services[a]	75,043	76,665	102,487	133,283	2.0	1.8	1.9
Tourism[a]	18,651	19,422	26,510	33,922	2.1	1.7	1.9
Federal Civilian	17,560	17,604	18,276	18,551	0.3	0.1	0.2
State Government	21,403	21,845	24,751	27,601	0.8	0.7	0.8
Local Government	33,449	34,308	38,645	44,227	0.8	0.9	0.9
Military	18,054	18,054	18,054	18,054	0.0	0.0	0.0
Proprietors	29,692	30,263	37,563	46,868	1.5	1.5	1.5

[a] Tourism includes activity also included in Transportation, Trade, and Services. To avoid duplication, data in the Tourism row are not included in the Alaska total.

Source: MAP model (see Appendix A, Section A.8).

transportation, trade, finance, services, and tourism. Each of these sectors would grow at between 1.7 and 2.0% on average each year over the entire renewal period, experiencing slightly lower growth rates during the second half of the renewal period. The natural-resource-based industries, such as mining (which includes the oil and gas sector), agriculture, forestry, and fishing, would all grow at less than the state average rate and would all experience lower growth rates during the second half of the renewal period. The construction industry would experience increased employment growth during the second half of the period, reflecting growth in the trade services and tourism industries.

Employment in federal, state, and local government is expected to experience less growth than would be the case for the state as a whole, with overall annual growth rates of 0.8% and 0.9% for state and local government, respectively, and 0.2% for federal government employment. Increases in local government employment are expected toward the end of the renewal period, with falling rates in state and federal government employment.

Unemployment in the state would gradually increase over the 30-year renewal period as declining oil production and pipeline throughput affected tax revenues and the remainder of the state economy. The unemployment rate would increase from 6.6% in 2004 to 7.1% in 2019 and 7.7% in 2034. These forecasts represent an average annual increase of 0.5% in unemployment over the entire renewal period (Table 4.3-10).

It is likely that the unemployment impacts presented here underestimate the number of people who would want to work, because the unemployment rate only includes persons who would be registering for unemployment benefits. During the renewal period, the number of employment opportunities in many Alaskan communities is likely to continue to be limited, meaning that additional people would not be actively searching for employment.

4.3.19.3.4 Personal Income. Real personal income (which excludes the effects of inflation on personal incomes over time) is expected to increase at an annual average rate of 1.8% over the renewal period, with a slightly lower rate in the second half of the period (Table 4.3-11). Per capita incomes would rise slightly faster in the second period, with an overall average annual growth rate of 0.2% over the entire period. The contribution of transfer

TABLE 4.3-10 Projected Labor Force Participation, Employment, and Unemployment Rates

	Statistics by Year				Average Annual Rate of Growth (%)		
Parameter	2003	2004	2019	2034	2004 to 2019	2019 to 2034	2004 to 2034
Total population	667,863	681,565	881,875	1,099,363	1.7	1.5	1.6
Potential labor force	463,354	472,059	587,413	724,633	1.5	1.4	1.4
Labor force	360,732	367,223	455,064	556,107	1.4	1.4	1.4
Labor force participation rate (%)	78	78	78	77	0.0	-0.1	-0.1
Employment[a]	336,427	343,042	422,966	513,305	1.4	1.3	1.4
Unemployment rate (%)	6.7	6.6	7.1	7.7	0.5	0.6	0.5

[a] Employment of Alaska residents only; does not include nonresidents.

Source: MAP model (see Appendix A, Section A.8).

TABLE 4.3-11 Projected State Personal Income and Alaska Permanent Fund Dividend (2000 dollars, except where noted)

Parameter	Income by Year				Average Annual Rate of Growth (%)		
	2003	2004	2019	2034	2004 to 2019	2019 to 2034	2004 to 2034
Total personal income (millions of 2000 dollars)	15,991	16,247	21,416	27,462	1.9	1.7	1.8
Personal income per capita	23,943	23,837	24,285	24,980	0.1	0.2	0.2
Transfer payments per capita	5,935	5,857	6,765	7,580	1.0	0.8	0.9
Transfer payments share of personal income (%)	24.8	24.6	27.9	30.3	0.8	0.6	0.7
Permanent Fund Dividend per capita	1,213	1,071	1,040	860	-0.2	-1.3	-0.7
Permanent Fund Dividend share of personal income (%)	5.1	4.5	4.3	3.4	-0.3	-1.4	-0.9

Source: MAP model (see Appendix A, Section A.8).

payments to personal incomes would grow from almost 25% of income in 2004 to more than 30% in 2034.

An important contributor to personal income in the state, particularly in rural areas, is the Alaska Permanent Fund Dividend, a per capita annual payment to individuals by the state from earnings on the investment of royalty payments made to the state by oil companies. The size of the Permanent Fund Dividend depends on the performance of the stock market. Assuming moderate growth in the size of the Permanent Fund, the Permanent Fund Dividend per capita would fall slightly, with growth in state population outpacing growth in the size of the fund. After contributing 4.5% to personal incomes at the beginning of the renewal period, the Dividend share of personal incomes would fall to 4.3% in 2019, and to 3.4% in 2034.

4.3.19.3.5 State and Local Tax Revenues. State tax revenues are projected to decline at an average annual rate of 0.5% over the 30-year renewal period (Table 4.3-12). With the projected level of state and local expenditures (Section 4.3.19.3.6), increasingly large annual budget deficits are likely during the renewal period given the current means of generating revenue in the state.

Taxes levied by the state on the oil industry have been a major source of revenue used to support a wide range of programs. Oil revenues are projected to decline at a fairly rapid rate over the renewal period as North Slope oil production begins to decline after 2005. Losses in oil

Options for Addressing the Deficit

Various fiscal policy options have been identified as means of addressing current revenue shortfalls, including a sales tax, reinstitution of a state personal income tax, a cap on the Permanent Fund Dividend, changes in petroleum sector tax rates, state and local expenditure reductions, and the use of a portion of the earnings on the Permanent Fund currently used for the Permanent Fund Dividend. While a number of these options, notably a personal income tax and the use of some portion of the earnings from the Permanent Fund, have already been proposed by various parties to address current state budgetary problems, this analysis does not include any of those options in the estimation of the impact of declining pipeline throughput rates on state and local tax revenues. No such options are included in the analysis because of the uncertainty surrounding the likely use and timing of any particular fiscal policy option.

revenues would be particularly marked in the second half of the renewal period, with an annual rate of decrease of 4.5% in the first period, followed by an annual decline of 6.5% over the second period, producing an average rate of decline of 5.5% over the entire period (Table 4.3-12). Revenues from production taxes, corporate income taxes, and property taxes would all decline significantly over the renewal period, with the steepest declines in royalties and production taxes in the second half of the renewal period.

Only moderate growth in nonpetroleum revenues from existing sources together with declining investment earnings would mean that state revenues would likely continue to fall throughout the renewal period with declining North Slope production (see Section 4.3.19.1.2).

Despite falling TAPS throughput, tax revenues collected by incorporated communities and boroughs are expected to grow at an annual average rate of 0.8% over the entire renewal period, with larger increases over the second 15 years (Table 4.3-13). This projection is based on the assumption that state transfers to local governments would not be affected by declining state oil revenues with declining TAPS throughput. Despite increasingly large state budget deficits that are projected with the current means of generating revenue (see above) and the uncertainty regarding selection of any particular option to increase revenues or reduce expenditures at the state level and the consequent impact on state transfers to local governments, this analysis assumed that the necessary state revenues would be found to support projected local government expenditures

TABLE 4.3-12 Projected State Revenues (millions of 2000 dollars)

	Revenue by Year				Average Annual Rate of Growth (%)		
Revenue Source	2003	2004	2019	2034	2004 to 2019	2019 to 2034	2004 to 2034
Total oil revenues	1,451	1,382	696	256	-4.5	-6.5	-5.5
Bonuses	17	17	12	9	-2.0	-2.0	-2.0
Rents	16	16	16	17	0.2	0.2	0.2
Property taxes	39	36	12	8	-7.2	-2.4	-4.8
Royalties	699	715	415	116	-3.6	-8.2	-5.9
Production taxes	407	404	153	42	-6.3	-8.2	-7.3
Corporate taxes	151	139	42	27	-7.7	-3.0	-5.4
Miscellaneous petroleum revenues	113	46	34	26	-2.0	-2.0	-2.0
Federal-state shared petroleum revenues	11	11	11	11	0.2	0.2	0.2
Nonpetroleum revenues	448	452	513	579	0.9	0.8	0.8
Investment earnings	1,874	1,884	1,836	1,569	-0.1	-1.0	-0.6
Federal grants	1,224	1,277	1,570	1,874	1.4	1.2	1.3
Total state revenues	4,998	4,995	4,615	4,278	-0.5	-0.5	-0.5

Source: MAP model (see Appendix A, Section A.8).

TABLE 4.3-13 Projected Local Revenues (millions of 2000 dollars, except where noted)

	Local Revenues by Year				Average Annual Rate of Growth(%)		
Revenue Source	2003	2004	2019	2034	2004 to 2019	2019 to 2034	2004 to 2034
Local revenues[a]	1,957	1,971	2,261	2,715	0.9	1.2	1.1
Property taxes[b]	697	692	763	1,001	0.7	1.8	1.2
Petroleum	189	176	57	40	-7.2	-2.4	-4.8
Nonpetroleum	508	516	706	961	2.1	2.1	2.1
Petroleum share of total property taxes (%)	27	25	7	4	-7.8	-4.1	-6.0
Other taxes	156	159	218	296	2.2	2.0	2.1
State transfers	969	985	1,117	1,225	0.8	0.6	0.7
Federal transfers	134	136	162	193	1.2	1.2	1.2
Charges and miscellaneous revenue	740	734	682	692	-0.5	0.1	-0.2
Total general revenues[c]	2,697	2,705	2,943	3,407	0.6	1.0	0.8

[a] Local revenues are the sum of property and other taxes and state and federal transfers.

[b] Property taxes are the sum of petroleum and nonpetroleum property taxes.

[c] Total general revenues are the sum of local revenues and charges and miscellaneous revenues.

Source: MAP model (see Appendix A, Section A.8).

over the renewal period. The impact of declining North Slope production would be reflected at the local level in terms of falling oil-related property tax revenues, which would drop from more than 25% of property tax revenues in 2004 to about 4.0% in 2034. Federal and state transfers to local government, which together are projected constitute about 45% of total local revenues, would continue to grow at a relatively stable rate over the entire period, offsetting the shortfalls in local revenue resulting from declining petroleum property taxes.

4.3.19.3.6 State and Local Expenditures. State government expenditures are expected to grow at an annual rate of 0.7% over the entire renewal period, with slightly higher growth during the second half of the period (Table 4.3-14). Expenditures on education would grow from about one-fifth of overall state spending in 2004 to more than one-third in 2034. They would grow at an annual rate of 0.9% over the entire renewal period, with slightly lower growth during the second half of the period. Expenditures for general government (0.8%) and social services (1.3%) are also expected to grow slightly faster than overall state expenditures, also with slightly less growth during the second half. Despite the growth in education spending, education expenditures are not expected to keep pace with population growth, resulting in a 0.7% decline in per capita expenditures over the entire renewal period, while overall state per capita expenditures would also be expected to decrease at an annual rate of 0.9%.

TABLE 4.3-14 State Government Expenditures (millions of 2000 dollars, except were noted)

Item	Expenditures by Year				Average Annual Rate of Growth (%)		
	2003	2004	2019	2034	2004 to 2019	2019 to 2034	2004 to 2034
General Government	894	910	1,046	1,181	0.9	0.8	0.9
Education	1,802	1,834	2,112	2,386	0.9	0.8	0.9
Social services	901	921	1,121	1,344	1.3	1.2	1.3
Transportation	522	529	575	614	0.6	0.4	0.5
Environment	339	345	394	441	0.9	0.8	0.8
Capital outlay and debt service	1,386	1,325	1,175	1,299	-0.8	0.7	-0.1
Total State Expenditures	5,843	5,863	6,423	7,264	0.6	0.8	0.7
Expenditures per Capita (2000 dollars)	8,750	8,603	7,283	6,608	-1.1	-0.6	-0.9

Source: MAP model (see Appendix A, Section A.8).

At the local level, growth in educational expenditures for the renewal period (1.3%) is expected to be higher than the overall rate of local expenditure growth (0.8%) (Table 4.3-15). As a result, educational expenditures would continue to make up a large portion of total expenditures, increasing from 34% of all expenditures in 2004 to 39% in 2034. As is the case at the state level, however, expenditures on education are not expected to keep pace with population growth, meaning that per capita expenditures would decline by 0.4% over the entire renewal period. Overall local per capita expenditures are also expected to decrease, with an annual rate of –0.8%.

4.3.19.4 Sensitivity of Impacts to Changes in TAPS Throughput and Changes in World Oil Prices

4.3.19.4.1 Changes in TAPS Throughput. Estimation of the economic impacts of continued TAPS operation used forecasts of annual North Slope production from the DOE-EIA forecast (DOE 2001a). This forecast combines estimates of current production and production from identified developments with production from undiscovered resources. Probability estimates at the 5% and 95% confidence levels were established for production from undiscovered fields in order to estimate possible upper and lower bounds for overall production levels presented in these forecasts. For the purposes of this analysis, the estimation of impacts of the proposed action used the annual mean value of the forecasted production upper and lower bound. Table 4.3-16 shows selected forecasted production levels for the upper and lower bound and the mean of the two estimates. Because actual production levels might vary from the mean value depending on physical considerations (e.g., recovery success rates), and economic considerations (e.g., world crude oil prices, pipeline transportation costs) impacts on the economy of the state might also vary. To bound these impacts, effects from production at the lowest (the 95% case) and highest forecasted production levels (5% case) have been estimated.

TABLE 4.3-15 Local Government Expenditures (millions of 2000 dollars, except were noted)

Item	Expenditures by Year				Average Annual Rate of Growth (%)		
	2003	2004	2019	2034	2004 to 2019	2019 to 2034	2004 to 2034
Education	1,259	1,280	1,552	1,855	1.3	1.2	1.3
Noneducation expenditures	930	933	993	1,034	0.4	0.3	0.3
Personnel expenditures	1,293	1,307	1,474	1,688	0.8	0.9	0.9
Interest on debt	274	255	165	218	-2.9	1.9	-0.5
Total expenditures	3,756	3,775	4,184	4,795	0.7	0.9	0.8
Expenditures per capita (2000 dollars)	5,624	5,539	4,745	4,361	-1.0	-0.6	-0.8

Source: MAP model (see Appendix A, Section A.8).

TABLE 4.3-16 Forecasted Range for North Slope Oil Production (millions of bbl/d)

Year	High-Probability Case	Mean Case	Low-Probability Case
2005	1,069	1,084	1,084
2010	742	961	1,091
2015	577	888	1,282
2020	402	723	1,302
2025	257	509	1,014
2030	162	315	624
2034	106	208	416

Source: DOE (2001a).

The largest impact of production at the lower bound (the 95% case) of the production range would be the impact on oil revenues collected by the state, which would fall by almost 35% compared with the mean forecast case by 2019, and by 30% by the end of the renewal period (Table 4.3-17). The decline in oil revenues would be reflected in a 7.0% decline in overall state revenues compared with the mean forecast by 2019, and by 5.7% by 2034. Elsewhere in the economy of the state, differences between the impacts of low case and the mean case would be small, with relatively minor impacts on employment, gross state product, and personal incomes. Minor decreases in population would be experienced in the state at the low end of the production range compared with the mean case.

Production at the upper bound of the forecast would produce huge differences in oil revenues (61.7%) and large differences in state revenues (9.3%) compared with the mean forecast by the end of the renewal period. Production at the 5% probability level would only produce slight increases in gross state product compared with the mean case. Population in the state would increase only slightly compared with the mean case.

4.3.19.4.2 Sensitivity of Impacts to Changes in World Oil Prices. Political and economic instability in many of the world's oil producing countries, combined with potential production restrictions by groups of oil producing countries, make fluctuations in world crude oil prices likely. Within a certain range, relatively minor changes in oil prices that may not affect pipeline throughput rates still have the potential to affect the economy of the state through their effects on state revenue collections, employment, gross state product, incomes, and employment opportunities for migrants from outside the state. The impacts of minor price

TABLE 4.3-17 State Economic Effects of Changes in TAPS Oil Throughput Rates (millions of 2000 dollars, except where noted)

	Effects by Year				Change Compared with Mean Forecast (%)		
Parameter	2003	2004	2019	2034	2004	2019	2034
95% Probability Case							
Total population (number)	667,863	681,565	881,698	1,099,363	0.0	0.0	0.0
Net migration (number)	6,547	7,290	6,620	3,870	0.0	-0.2	0.0
Total employment (number)	342,047	348,345	424,884	514,802	0.0	0.0	0.0
Gross state product	23,310	23,877	27,645	30,651	0.0	-1.0	-0.3
Personal income per capita (2000 dollars)	23,943	23,837	24,284	24,980	0.0	0.0	0.0
Permanent Fund Dividend per capita (2000 dollars)	1,213	1,071	1,040	860	0.0	0.0	0.0
Permanent Fund Dividend share of personal income (%)	5.1	4.5	4.3	3.4	0.0	0.0	0.0
Total state revenues	4,998	4,995	4,292	4,036	0.0	-7.0	-5.7
Oil revenues	1,451	1,382	455	178	0.0	-34.5	-30.4
Local revenues	2,697	2,705	2,942	3,407	0.0	0.0	0.0
5% Probability Case							
Total population (number)	667,863	681,565	882,106	1,099,381	0.0	0.0	0.0
Net migration (number)	6,547	7,290	6,412	3,874	0.0	-3.4	0.1
Total employment (number)	342,047	348,345	425,032	514,813	0.0	0.0	0.0
Gross state product	23,310	23,877	28,471	30,931	0.0	1.9	0.6
Personal income per capita (2000 dollars)	23,943	23,837	24,280	24,980	0.0	0.0	0.0
Permanent Fund Dividend per capita (2000 dollars)	1,213	1,071	1,039	860	0.0	0.0	0.0
Permanent Fund Dividend share of personal income (%)	5.1	4.5	4.2	3.4	0.0	0.0	0.0
Total state revenues	4,998	4,995	5,159	4,677	0.0	11.8	9.3
Oil revenues	1,451	1,382	1,148	414	0.0	65.0	61.7
Local revenues	2,697	2,705	2,943	3,407	0.0	0.0	0.0

Source: MAP model (see Appendix A, Section A.8).

changes on the Alaska economy are shown in Table 4.3-18. Price changes shown are a 10% increase and a 10% decrease in the world price of crude oil over the price assumed for the baseline proposed action case in each year of the renewal period. Changes in the levels of economic activity are compared with the corresponding levels estimated for the baseline proposed action case.

A 10% increase in the world price of crude oil would increase oil revenues by 6.2% over the baseline proposed action case. General revenues at the state level would increase 0.7% over the base case on average over the entire renewal period. Small additional increases in gross state product would also occur because slightly higher levels of oil-sector-related spending and expenditures by state and local government would increase the overall level of economic activity in the state. The increase in oil prices would also have the effect of slightly reducing average population growth and net migration in the second half of the renewal period compared with the baseline.

A 10% decline in oil prices would have a slightly depressing effect on the Alaskan economy in all respects compared with the proposed action case (Table 4.3-18). State government (-1.7%), and especially oil (-6.2%) revenues would fall compared with the baseline proposed action case, with smaller differences in gross state product compared with the base case. A decrease in oil prices would lead to a slightly larger number of in-migrants arriving in the state in the second half of the renewal period compared with the base case.

4.3.19.5 Regional Economic Impacts

The impacts of continued TAPS operation on the regional economies along the pipeline corridor include impacts on population (including net migration), employment, personal incomes, and local government finances and public service employment. While changes in economic activity in the pipeline corridor would occur with continued TAPS operation, the overall level of activity in the region is not expected to be as closely related to declining TAPS throughput over the renewal period as is likely to be the case at the state level. In the pipeline corridor, as is the case at the local level elsewhere in the state, transfers to local jurisdictions create significant local employment and income. In addition, transfers from federal sources, together with steady growth in population and income in the Alaska Native community, provide additional spending power independent of TAPS in the local economies in the region.

It was assumed for the analysis that state transfers to local governments would not be affected by reductions in state oil revenues with declining TAPS throughput. While increasingly large state budget deficits are projected with the current means of generating revenue, a number of fiscal policy options have been considered by various parties to address the current and likely future fiscal situation (see Section 4.3.19.3.5). Given the uncertainty surrounding the use and timing of any particular option to increase revenues or reduce expenditures, however, and the consequent impact on state transfers to local governments, the analysis assumed that the necessary state revenues would be found to support projected local government expenditures over the renewal period.

4.3.19.5.1 Population. Little variation in population growth is expected along the pipeline corridor with continued TAPS operation, with the same growth rates projected for the pipeline corridor (1.6%) over the entire renewal period as for the state as a whole (Table 4.3-19). Within the corridor, annual average growth rates would range from 1.3 to 1.7%, with slightly higher rates expected for Anchorage, the North Slope Borough, and the Yukon-Koyukuk Census Area. With the exception of the Fairbanks North Star Borough, slightly lower growth rates are expected in the second half of the renewal period.

4.3.19.5.2 Employment. Moderate employment growth would occur along the pipeline corridor as a whole following the renewal of the Federal Grant, with total employment in the region expected to grow at an average annual rate of 1.4% over the entire period. A slightly higher than average rate of growth for the entire period would be expected in Anchorage (Table 4.3-20).

TABLE 4.3-18 State Economic Effects of Changes in Crude Oil Prices (millions of 2000 dollars, except where noted)

Item	Effects by Year				Change Compared with Baseline (%)		
	2003	2004	2019	2034	2004 to 2019	2019 to 2034	2004 to 2034
10% Increase in Oil Prices							
Total population (number)	667,863	681,565	881,826	1,099,369	0.0	0.0	0.0
Net migration (number)	6,547	7,290	6,477	3,871	0.0	-2.4	0.0
Total employment (number)	342,047	348,345	424,889	514,807	0.0	0.0	0.0
Gross state product	23,310	23,993	27,998	30,762	0.5	0.2	0.1
Personal income per capita (2000 dollars)	23,943	23,837	24,281	24,980	0.0	0.0	0.0
Permanent Fund Dividend per capita (2000 dollars)	1,213	1,071	1,040	860	0.0	0.0	0.0
Permanent Fund Dividend share of personal income (%)	5.1	4.5	4.3	3.4	0.0	0.0	0.0
Total state revenues	4,998	5,107	4,736	4,308	2.3	2.6	0.7
Oil revenues	1,451	1,494	753	272	8.1	8.2	6.2
Local revenues	2,697	2,705	2,943	3,407	0.0	0.0	0.0
10% Decrease in Oil Prices							
Total population (number)	667,863	681,565	881,888	1,099,360	0.0	0.0	0.0
Net migration (number)	6,547	7,290	6,770	3,871	0.0	2.0	0.0
Total employment (number)	342,047	348,345	425,077	514,804	0.0	0.0	0.0
Gross state product	23,310	23,761	27,869	30,724	-0.5	-0.2	-0.1
Personal income per capita (2000 dollars)	23,943	23,837	24,288	24,980	0.0	0.0	0.0
Permanent Fund Dividend per capita (2000 dollars)	1,213	1,071	1,040	860	0.0	0.0	0.0
Permanent Fund Dividend share of personal income (%)	5.1	4.5	4.3	3.4	0.0	0.0	0.0
Total state revenues	4,998	4,882	4,522	4,207	-2.3	-2.0	-1.7
Oil revenues	1,451	1,270	639	240	-8.1	-8.2	-6.2
Local revenues	2,697	2,705	2,942	3,407	0.0	0.0	0.0

Source: MAP model (see Appendix A, Section A.8).

TABLE 4.3-19 Projected Pipeline Corridor Region Populations[a]

Location	Population by Year				Average Annual Rate of Growth (%)		
	2003	2004	2019	2034	2004 to 2019	2019 to 2034	2004 to 2034
Pipeline corridor total	400,806	408,673	528,302	657,841	1.7	1.5	1.6
Anchorage	280,111	286,049	378,248	475,519	1.9	1.5	1.7
Fairbanks North Star Borough	86,794	88,071	106,800	129,609	1.3	1.3	1.3
North Slope Borough	7,421	7,586	9,671	11,835	1.6	1.4	1.5
Southeast Fairbanks Census Area	7,433	7,585	9,311	11,266	1.4	1.3	1.3
Valdez-Cordova Census Area	10,670	10,884	13,422	16,321	1.4	1.3	1.4
Yukon-Koyukuk Census Area	8,377	8,498	10,851	13,290	1.6	1.4	1.5

[a] The MAP model gives census area population projections only up to 2025. For the 2026 to 2034 period, the pipeline corridor population estimates were determined by using the annual state population growth rates for that period.

Source: MAP model (see Appendix A, Section A.8).

TABLE 4.3-20 Projected Pipeline Corridor Region Employment

Location	Employment by Year				Average Annual Rate of Growth (%)		
	2003	2004	2019	2034	2004 to 2019	2019 to 2034	2004 to 2034
Pipeline corridor total	222,953	227,116	279,406	339,517	1.4	1.3	1.4
Anchorage	161,670	164,752	207,312	257,425	1.5	1.5	1.5
Fairbanks North Star Borough	42,338	42,922	49,722	57,062	1.0	0.9	1.0
North Slope Borough	8,168	8,466	9,545	10,255	0.8	0.5	0.6
Southeast Fairbanks Census Area	2,009	2,045	2,376	2,709	1.0	0.9	0.9
Valdez-Cordova Census Area	5,648	5,749	6,700	7,745	1.0	1.0	1.0
Yukon-Koyukuk Census Area	3,120	3,182	3,751	4,321	1.1	1.0	1.0

Source: MAP model (see Appendix A, Section A.8).

4.3.19.5.3 Personal Income. Real per capita income (adjusted for the effects of inflation) would increase slightly over the entire renewal period in the pipeline corridor as a whole, with slight declines in the North Slope Borough. Elsewhere in the pipeline corridor, annual per capita income growth rates are expected to show slight increases in both halves of the renewal period (Table 4.3-21). Increases in population during the renewal period would lead to a reduction in the importance of the Permanent Fund Dividend to personal income. This trend would occur both in the constituent regions and in the pipeline corridor as a whole.

4.3.19.5.4 Local Government Revenues and Expenditures and Public Service Employment. Population, employment, and personal incomes in the pipeline corridor region are generally expected to experience moderate growth over the entire renewal period. At the state level, on the other hand, declining TAPS throughput is expected to contribute to a steadily worsening state deficit. However, this analysis assumed that the required revenue from various possible sources would be found to fund state expenditures, including state transfers to local governments (Section 4.6.2.19). With the availability of state funds for local expenditure programs, together with moderate population and economic growth in the pipeline corridor region, the impact of TAPS renewal on local public finances and public service employment in the region is, therefore, not expected to be significant.

4.3.19.6 Alaska Native Corporations

A number of Alaska Native corporations (see Section 3.23.6) provide contracting services to the pipeline. Although these services likely would continue over the renewal period, providing employment and income to Alaska Native corporation shareholders, the level of expenditures on these activities is likely to diminish with declining pipeline throughput. A moderate decline in the size of the Permanent Fund Dividend per capita as growth in the Alaskan population exceeds growth in the size of the Fund would have a minor effect on personal incomes of corporation shareholders.

Earnings on investments made by some of the corporations have the potential to partially offset the slight decline in personal incomes among shareholders.

4.3.19.7 Subsistence

Continued TAPS operation would have a minor impact on subsistence as the rate of increase in the Alaskan population exceeds the growth in the size of the Permanent Fund. This situation would affect the contribution of the Permanent Fund Dividend per capita to personal incomes in the Alaska Native community (see Section 4.3.19.3.4). Income growth, partly from the Permanent Fund Dividend, has led to some changes in the way subsistence activities have been undertaken, in particular hunting and fishing, through further encouragement of the use of modern equipment to supplement more traditional forms of subsistence activities.
A decline in income growth might affect the productivity of subsistence activities and create other socioeconomic impacts (see Section 4.3.20). Less income would be available for investment in subsistence-related equipment, and the demand for subsistence products would increase as the amount of income available for the purchase of consumer market goods would fall. Population growth during the renewal period would also increase pressure on subsistence resources.

4.3.20 Subsistence Impacts

Assessing impacts of the proposed action on subsistence is a difficult matter. If occurring, negative impacts would have to yield reduced subsistence success as a result of declining resource populations, changing subsistence resource locations, increased competition for resources, disruption of subsistence activities, reduced access to resources, or some combination of these factors that could be linked directly or indirectly to the TAPS and its continuation. Similarly, if occurring, positive impacts would have to yield increased harvests, presumably through increasing resource

TABLE 4.3-21 Projected Pipeline Corridor Personal Income (2000 dollars, except where noted)

Parameter	Personal Income by Year				Average Annual Rate of Growth (%)		
	2003	2004	2019	2034	2004 to 2019	2019 to 2034	2004 to 2034
Total Pipeline Corridor							
Disposable personal income per capita	25,002	24,902	25,394	26,186	0.1	0.2	0.2
Permanent Fund Dividend per capita	1,213	1,071	1,040	860	-0.2	-1.3	-0.7
Permanent Fund Dividend share of personal income (%)	4.9	4.3	4.1	3.3	-0.3	-1.5	-0.9
Anchorage							
Disposable personal income per capita	27,109	26,992	27,302	28,009	0.1	0.2	0.1
Permanent Fund Dividend per capita	1,213	1,071	1,040	860	-0.2	-1.3	-0.7
Permanent Fund Dividend share of personal income (%)	4.5	4.0	3.8	3.1	-0.3	-1.4	-0.9
Fairbanks North Star Borough							
Disposable personal income per capita	20,097	20,005	20,578	21,308	0.2	0.2	0.2
Permanent Fund Dividend per capita	1,213	1,071	1,040	860	-0.2	-1.3	-0.7
Permanent Fund Dividend share of personal income (%)	6.0	5.4	5.1	4.0	-0.4	-1.5	-0.9
North Slope Borough							
Disposable personal income per capita	18,412	18,392	18,256	17,990	-0.1	-0.1	-0.1
Permanent Fund Dividend per capita	1,213	1,071	1,040	860	-0.2	-1.3	-0.7
Permanent Fund Dividend share of personal income (%)	6.6	5.8	5.7	4.8	-0.2	-1.2	-0.7
Southeast Fairbanks Census Area							
Disposable personal income per capita	19,271	19,246	19,700	19,960	0.2	0.1	0.1
Permanent Fund Dividend per capita	1,213	1,071	1,040	860	-0.2	-1.3	-0.7
Permanent Fund Dividend share of personal income (%)	6.3	5.6	5.3	4.3	-0.4	-1.3	-0.9
Valdez-Cordova Census Area							
Disposable personal income per capita	22,609	22,494	23,340	24,334	0.3	0.3	0.3
Permanent Fund Dividend per capita	1,213	1,071	1,040	860	-0.2	-1.3	-0.7
Permanent Fund Dividend share of personal income (%)	5.4	4.8	4.5	3.5	-0.5	-1.5	-1.0

TABLE 4.3-21 (Cont.)

Parameter	Personal Income by Year				Average Annual Rate of Growth (%)		
	2003	2004	2019	2034	2004 to 2019	2019 to 2034	2004 to 2034
Yukon-Koyukuk Census Area							
Disposable personal income per capita	19,349	19,243	20,071	20,430	0.3	0.1	0.2
Permanent Fund Dividend per capita	1,213	1,071	1,040	860	-0.2	-1.3	-0.7
Permanent Fund Dividend share of personal income (%)	6.3	5.6	5.2	4.2	-0.5	-1.4	-0.9

Source: MAP model (see Appendix A, Section A .8).

populations, changing resource locations (closer to those pursuing subsistence), improving access to resources, improving ability to harvest, or some combination of these factors, once again linked directly or indirectly to the TAPS. However, available data do not enable researchers to make such assessments (see Section 3.24). Despite data inadequacies, the conclusion of this analysis is that any negative impacts to subsistence under the proposed action would be extremely small.

Under current conditions, which likely provide an indication of impacts to be expected for ROW renewal, subsistence by rural Alaskans appears to be experiencing several impacts. In part as a consequence of TAPS operation, people can acquire technology that improves both transportation to subsistence resources and the process of harvesting such resources. Individuals pursuing subsistence also may benefit from improved access to subsistence resources – although the benefits of better access likely are slight, and further restrictions on the use of access roads following the events of September 11, 2001, are reducing the benefits. Finally, populations of certain subsistence species have grown in recent years – the best documented being caribou, with the Central Arctic herd having increased more than fivefold (to about 27,000) between 1978 and 2000 and the state total to more than 857,000 in

Impacts of Proposed Action on Subsistence

Under the proposed action, several conditions would result that have implications for subsistence. However, available data do not provide a reliable basis from which to determine:

- The degree to which impacts are associated with the TAPS, as opposed to other possible causes; or

- The magnitude of most impacts, either individually or in combination.

The conclusion drawn in this analysis is that any negative impacts from the proposed action would be extremely small. This conclusion is based on restrictions on the use of certain areas traditionally used for subsistence, and the continued possibility of disrupting the movement of a few terrestrial land mammals because of the TAPS or TAPS-related vehicles and activity. It acknowledges that most potentially large negative impacts (e.g., competition for fish and game by nonlocals using the Dalton Highway) as well as large positive impacts (economic conditions providing cash for modern technology used in subsistence) are not necessarily associated with the TAPS.

2000 (Lenart 2000; TAPS Owners 2001a). Thus, one can get to subsistence resource areas more easily, traveling a greater distance if necessary, possibly have access to a greater number of resources, and harvest those resources more efficiently, at least in part due to the TAPS or a consequence of conditions that developed during the TAPS existence. Such impacts on subsistence would also be likely under the proposed action.

On the other hand, several potential negative impacts on subsistence associated with current conditions also would continue under the proposed action. Impacts related at least in part to TAPS operation include:

- Increased access by nonlocals (often urban residents), using TAPS maintenance roads or employed at TAPS facilities and potentially competing for or disrupting subsistence activities;
- Increased ability by nonlocals (often urban residents) to hunt and fish by virtue of having access financially to appropriate modern technology and monetary resources to pursue sport hunting and fishing;
- Increased numbers of people hunting and fishing, including nonlocal people (often urban residents) and individuals engaged in recreational, as opposed to subsistence, hunting and fishing;
- Possible disruption of movement patterns of certain terrestrial mammals and fish; and
- Certain constraints on hunting and fishing as a result of TAPS infrastructure and operation.

Many of the potential negative impacts listed above relate to issues identified by individuals pursuing a subsistence way of life and were described as subsistence concerns in Section 3.24.1. Such information is based at least in part on traditional ecological knowledge which is the accumulation of knowledge and beliefs handed down through generations regarding the relationship among living beings with one another and with their environmental surroundings (Berkes 1993). Usually associated with indigenous sociocultural systems, traditional ecological knowledge can provide a source of insight from people intimately familiar with their surroundings. This insight can be useful for (among other things) the assessment of environmental impacts (Sallenave 1994). Available information on subsistence concerns points consistently toward a decline in subsistence and blames much of this decline on the TAPS. However, even such consistent results are not necessarily conclusive, for although the observations of life-long subsistence hunters and fishermen regarding declining harvests and increasing difficulty of subsistence activities are very compelling, the assignment of cause in such a complex setting is another, challenging matter.

As discussed in Section 3.24, despite the importance of subsistence to many Alaskans, the data available with which to evaluate TAPS-related impacts on subsistence are largely inadequate. Two questions are central to this evaluation: (1) to what degree are the above effects, both positive and negative, a consequence of the TAPS; and (2) what are the net effects of TAPS-related impacts? Each question can be addressed in turn.

The identification of cause for potential impacts is particularly challenging in the case of subsistence under the proposed action. Many of the conditions characterizing modern Alaska are consequences, at least in part, of the presence of the oil industry, which has had an enormous impact on the state since the 1970s (Strohmeyer 1997). The inextricable association of the oil industry with the TAPS means that the latter is somehow related to many of the impacts listed above currently affecting subsistence. However, many of the relationships are indirect — such as contributions to an economy that provides the impetus for people (potential competitors for subsistence resources) to move to Alaska, provides the disposable income and time necessary to pursue sport hunting and fishing, and provides the cash necessary to purchase recreation- and subsistence-related equipment. Moreover, many of such impacts involve other causes as well. The economic conditions that are present in Alaska (resulting from several economic activities) provide a good example. Another example is the issue of competition from nonlocal hunters and fishermen, who gain access to subsistence areas, who have the economic ability to pursue recreational hunting and fishing, and who reside in Alaska in large numbers for many reasons besides the TAPS or the oil industry. Traditional ecological knowledge tends to identify the TAPS as causing many subsistence problems, but as noted above, the complex issue of causality is difficult to evaluate with such information.

The evaluation of both the magnitude of individual impacts and the net effects of these impacts taken together also is a difficult undertaking with the data available. The access issue, which underlies many concerns about competition by nonlocal (often urban) residents for fish and game, likely is affected relatively little by TAPS access roads because of their relatively small number and restricted length (providing primarily local access in some areas). Moreover, such access roads likely will have less effect given the additional restrictions placed on their use since September 11, 2001, as noted above. The greatest concern regarding increased access tends to involve the Dalton Highway, originally constructed as a road to support construction and operation of the TAPS but now operated and maintained by the State of Alaska. This highway, arguably a main means of surface access to central Interior Alaska, will remain, regardless of the decision for renewal, and hence is not an issue in the current analysis (that is, it is not technically a part of the proposed action).

Economic and demographic conditions in modern Alaska likely contribute both positive and negative impacts to subsistence, but the magnitude of either contribution and the degree to which the positive outweighs the negative (or vice versa) remain unclear. The populations of most subsistence resource species appear to be adequate, with some growing considerably, as discussed in Sections 3.18 through 3.22. However, the geographic distributions of these various resource populations, and the question of whether they have become more inaccessible over time, are separate issues. Here the evidence is unclear. Traditional ecological knowledge indicates that the TAPS has adversely affected caribou migration, making this key subsistence resource more inaccessible (see Section 3.24.1). In contrast, biological studies indicate that apart from effects on individual animals, most caribou, moose, and other terrestrial species, negotiate the TAPS and the Dalton Highway with at most temporary delays (see Section 4.3.17.4). Mitigation measures, in turn, adequately address possible hindrances to fish passage that might arise due to TAPS-related activities (see Section 4.3.16.2). Finally, there are constraints on hunting and fishing in certain areas associated with the TAPS traditionally used for subsistence. However, the constraints associated with the ROW involve an extremely small area when compared with traditional subsistence-harvest areas (see Figure 3.24-1 and Appendix D), suggesting that the magnitude of these impacts would be similarly small.

Given the available evidence, the conclusion drawn here is that any negative impacts on subsistence of renewing the Federal Grant would be extremely small. This conclusion is based on two consequences of grant renewal:

- Limited access to (very small) parts of certain traditional subsistence harvest areas; and
- The continued use of the Dalton Highway to maintain TAPS operations, along with various access roads and airspace over the TAPS, and continued human activity around the TAPS — possibly disrupting the movement of small numbers of terrestrial mammals.

Although both of these impacts are associated with grant renewal, as discussed above the impacts of both would be extremely small. The continued presence of TAPS personnel in remote areas as possible competitors for fish and game is also a possible concern, but the degree to which these individuals pursue sport hunting and fishing is unknown (and the impacts likely quite small and probably geographically limited). Any potential impacts on subsistence due to accidents, such as oil spills, would not be part of normal operations under the proposed action and are considered instead in Section 4.4.4.14. Although subsistence possibly has experienced substantial negative impacts over the past several decades, at least locally, these impacts are not clearly associated with the TAPS to the exclusion of other potential causes.

4.3.21 Sociocultural Systems

4.3.21.1 Alaska Native Sociocultural Systems

The proposed action of renewing the Federal Grant for the TAPS ROW would play an important role in continuing the interaction between Alaska Native sociocultural systems and the oil industry. This interaction, as well as continued modernization in Alaska made possible largely from oil revenues, would contribute to further change in Alaska Native sociocultural systems. Sociocultural systems by their very nature evolve; as a result, change is not inherently good or bad. Thus, the evaluation of impacts to sociocultural systems under the proposed action must consider the nature of the changes likely to occur and evaluate their various qualities in the context of the sociocultural system(s) in question. The conclusion reached, discussed in greater detail below, is that the proposed action would contribute to continued change in Alaska Native sociocultural systems that likely would be negative though very small.

Impacts of Proposed Action on Sociocultural Systems

Overall impacts of the proposed action on sociocultural systems would likely be negative but small. Possible positive consequences would include (1) continued access to cash employment, even in rural areas – important to supplement subsistence in mixed economies, and (2) continuation of state-funded programs and public services, important to many rural communities and to both Native and non-Native sociocultural systems.

On the other hand, possible negative consequences would include (1) continued growth in importance of cash economy and Alaska Natives' (especially) need to participate in an economy for which they may not be particularly well prepared; (2) continued fragmentation of rural Alaska Native and non-Native sociocultural systems, as some individuals leave to pursue other opportunities; and (3) continued loss of isolation from conventional modern American culture and the many rapid changes that tend to accompany interaction with it.

Inasmuch as the TAPS is linked to the oil industry in Alaska as a whole, renewal of the Federal Grant would make important direct and indirect economic contributions to Alaska Native sociocultural systems. Probably the most important for Alaska Natives are the many types of state-funded public services, programs, and infrastructure that play key roles in modern Alaska Native existence — such as the General Fund community support programs. These programs provide a range of state-funded assistance under the state revenue sharing program, the safe communities (municipal assistance) program, legislative grants, and capital project matching grants, which provide funds to eligible communities for a range of infrastructure development and maintenance activities and public services (ADCBD 2002a,b). These state programs would not be possible in their present form without revenues paid to the state by the oil industry (see Sections 4.3.19 and 4.6.2.19). Their loss, or substantial reduction, would be keenly felt by rural Alaskan communities, many of which are Alaska Natives (see Table 3.29-1) (see ADCED 2000b). Access to such services has implications well beyond convenience or enhanced lifestyle in rural communities, having yielded tangible results such as improved Alaska Native health and educational attainment (e.g., Alaska Department of Health and Social Services 2001a; North Slope Borough 1999). Another important consequence of continuing the TAPS would be continued access to wage employment for many Alaska Natives at levels likely similar to those currently found. Certainly the beneficiaries of this employment would include those living in the vicinity of the pipeline and involved in its operation or maintenance. APSC compliance with agreements established under Section 29 of the Federal Grant provides a base level for this employment (see APSC 1998d; Naylor and Federal Gooding 1978), with 2001 Native hires reaching 517 (APSC 2002b). However, the dominance of the oil industry in Alaska means that it affects much of the state economy — providing jobs in areas not directly related to the TAPS, or for that matter, the oil industry.

For the 8 Alaska Native sociocultural systems and the 21 rural (largely) Alaska Native communities considered in this study, the impacts of the TAPS would vary but tend to be relatively small. All of these peoples are heavily acculturated as a consequence of more than a century of interaction with Euro-Americans and the widespread changes that occurred throughout Alaska beginning in the 1950s (see Haycox 2002; Schneider 1986). As a result, modern Native sociocultural systems feature many of the characteristics found in modern American society. Similarly, the economies of all of the Alaska Native sociocultural systems and affected villages are to some degree mixed (Wolfe and Walker 1987) — that is, based on a combination of subsistence and cash, with the latter providing an important resource and contributing to (although not always necessary for) the pursuit of a modern subsistence lifestyle.

In the case of the Eyak, near Prince William Sound, anticipated sociocultural impacts would be negligible as years of depopulation and acculturation have left only remnants of the original sociocultural system. The two Iñupiat sociocultural systems examined in this DEIS, in contrast, present a substantially different situation. Much of their traditional sociocultural system remains — certainly the importance of kinship, both an economic and cultural reliance on traditional subsistence resources, respect for knowledge of traditional cultural behavior, and, in the case of the Tareumiut, even persistence of a traditional settlement system with its largely sedentary base. Of all Native peoples in Alaska, the Iñupiat have benefited more financially from the oil that flows through the TAPS. Such financial success has introduced a larger amount of change than most Alaska Native sociocultural systems have experienced recently. Many Iñupiat interact frequently with non-Natives, the latter present in relatively large numbers both to work in the oil fields and to provide various services. Oil revenues also provide resources for many changes generally considered positive, such as jobs, access to quality modern health care, infrastructure, and a range of social programs (Strohmeyer 1997). Ultimately, the continuation of the TAPS likely would fuel the mechanisms of change among Iñupiat sociocultural systems. Such changes, however, would continue to include many desirable things made available through access to cash resources, such as expanded participation in subsistence; improved communication, infrastructure, and public services; and increased ability for people to remain in villages if they so choose.

For the remaining Native sociocultural systems examined, anticipated impacts under the proposed action would lie somewhere between those outlined above. For the Chugach Alutiiq, a sociocultural system much changed through considerable interaction with non-Natives, relatively few impacts are anticipated under the proposed action beyond continued access to cash — primarily through employment in TAPS-related jobs and indirect employment. For the four regional Athabascan sociocultural systems — Ahtna, Tanana, Koyukon, and Gwich'in — likely impacts under the proposed action would be similarly minimal. Despite their relative geographic isolation (particularly the Tanana, Koyukon, and Gwich'in), all of these sociocultural systems have changed considerably from precontact times. Currently they combine features from Native and non-Native systems, and the proposed action would continue the incremental adoption of characteristics from the latter — once again in part made possible through continued access to cash via wage labor.

As with many potential impacts under the proposed action, access to money can have both positive and negative effects on sociocultural systems. Although money provides the means of purchasing goods and services necessary for survival, it also provides the means of acquiring substances detrimental to a healthy existence (Kettle and Bixler 1991; Kraus and Buffler 1979). Moreover, the acquisition of cash requires Alaska Natives to compete in a job market where competition and participation can be difficult (in part because of cultural differences) (Hudson 1985), thereby providing another source of potential pressure in a social system that has experienced considerable change over the past century or so, and particularly rapid change since 1971. Alaska Native employment on the TAPS construction provided a sense of the varied impacts of cash that are possible (Strohmeyer 1997). Full-time earnings well exceeded levels to which most Alaska Natives were accustomed — in a single month exceeding what many families in villages earned in a year and enabling the purchase of many items that improved rural life. But exposure to relatively large amounts of cash caused tensions with those who remained in the villages. Many individuals seeking cash income left villages for long periods (if not permanently), undermining a key part of the collaborative tradition that formed the foundation for the subsistence economy. Individuals who profited from pipeline employment in some cases sought changes to traditional sociocultural systems. And some of those who returned to rural life from work on the TAPS brought illegal drugs with them, the first appearance of these substances in Alaska Native villages. Many Alaska Natives noted both the positive and negative implications of monetary resources during public scoping for this EIS.

To develop a better sense of potential impacts under the proposed action, it is useful to examine such changes when the TAPS was first constructed and brought on line to provide a sense of what is possible. Access of Alaska Natives to cash, both during construction and operation, certainly occurred at levels greater than pre-TAPS. Alaska Natives consequently increased their participation in the modern Alaskan economy (Naylor and Gooding 1978). On the whole, they also experienced an increase in certain social problems, including substance abuse and suicide (Andon 1997; Kettle and Bixler 1993; Hlady and Middaugh 1988; Kraus and Buffler 1979; McNabb 1990). As discussed in Section 3.25.1, however, such social problems emerged well before the TAPS was there, grew following the onset of statehood, and continued to increase in a period that featured both the TAPS and other sources of sociocultural change, including wage labor from other sources not related to the pipeline. Thus, such consequences are not exclusively a consequence of the pipeline, though the TAPS likely contributed to the general conditions that lead to such problems.

As defined here, sociocultural systems are collections of adaptive mechanisms that evolve to meet various challenges posed by natural and social surroundings. Alaska Native sociocultural systems have experienced rapid changes for more than a century in the face of increased interaction with Euro-Americans, the pace increasing beginning in the middle of the 20th century (Morehouse et al. 1984). The construction and operation of the TAPS occurred in the midst of this more recent phase of accelerated change, and in many ways is inextricably interwoven with other major sources of impact such as ANCSA (Berry 1975; Berger 1985). Access to wage labor and additional cash through the TAPS no doubt had an impact on Alaska Native sociocultural systems, but the amount and type of impacts are unclear because of the presence of other changes as well, including the following:

- The emergence of regional and village corporations;
- An increase in Alaska Native political awareness and activity;
- Growing social, political, and economic interaction with the Euro-American (later, American) world (see Reckord 1979); and
- Reduced isolation of many rural Alaska Native villages because of dramatic improvements in transportation and communication.

In general terms, the proposed action would promote continued sociocultural change for Alaska Natives, with all of its positive and negative connotations. But these sociocultural systems in a sense are accustomed to the TAPS and the impacts associated with it. This familiarity, coupled with the inability to isolate TAPS-related changes from other changes associated with the modern world, leads to the conclusion that impacts on Alaska Native sociocultural systems under the proposed action likely would have a net negative effect brought about through continued modernization and a need to participate increasingly in activities that are culturally unfamiliar. The magnitude of these impacts likely would be small.

4.3.21.2 Non-Native Sociocultural Systems

Impacts on rural non-Native sociocultural systems also likely would originate in economic issues, although rural non-Native economies once again are mixed and involve some combination of wage labor and subsistence. In rural settings, the proposed action would provide some access to cash income in settings where such income can be elusive — through both direct employment on TAPS-related activities and indirect employment generated by the availability of TAPS-related cash in rural communities (see Section 4.3.19). The proposed action also would enable the State of Alaska to continue providing public services, government programs, and infrastructure in rural settings at current levels (as noted in Section 4.3.21.1) something extremely important in isolated places (also discussed in Section 4.3.19). Actual impacts on the sociocultural systems of rural non-Natives probably would primarily consist of continuing the existing trends of further loss of individuality and isolation, disruption of established interaction patterns, and growing exposure to modern American society (see Coates 1993; Johnson 1992; Lounsbury 1992; Scott 1998).

The anticipated impacts on rural non-Native sociocultural systems under the proposed action are as important to consider as those for Alaska Native sociocultural systems. In a similar manner, they are not necessarily bad given that adaptation to changing situations is inherent in sociocultural systems. It is impossible to identify the TAPS as the primary source of likely changes during the renewal period, given the many sources of change in a rapidly modernizing Alaska. Nevertheless, the TAPS no doubt would contribute to change in non-Native sociocultural systems, providing more cash and introducing outsiders to rural Alaska (Scott 1998). When all considerations are weighed, impacts on rural non-Native sociocultural systems under the proposed action likely will be negative, though very small.

4.3.22 Cultural Resources

Renewal of the Federal Grant for 30 years could have the potential to adversely affect known cultural resources. However, those adverse effects could likely be mitigated in various ways, such as through avoidance, data recovery, and monitoring. Any mitigation measures would be determined on a case-by-case basis through consultation with the Alaska SHPO. The possibility also exists that previously unreported resources could be encountered during continued operation of the pipeline and its associated facilities. Impacts from oil spills are discussed in Section 4.4.4.16.

Three types of cultural resources could be encountered: archaeological sites, traditional cultural properties, and historic structures. Only archeological sites are currently known to exist in the ROW. However, the review of information on cultural resources conducted for this DEIS identified deficiencies and gaps in the current data (see Section 3.26). Of particular note is the absence of any reported traditional cultural properties along the ROW. Given the presence of Alaska Natives throughout the area and the general difficulty in obtaining information on traditional cultural properties (which Alaska Natives tend to guard closely), it would not be unexpected to discover that some such resources actually occur within or immediately adjacent to the TAPS along its 800-mi length or in the vicinity of associated facilities. However,

Impacts of Proposed Action on Cultural Resources

Although renewal of the Federal Grant for the TAPS ROW and continued operation of the pipeline for 30 more years could have the potential to adversely affect known and previously unreported cultural resources, mitigation measures would be developed through consultation with the Alaska SHPO on a case-by-case basis. Such mitigation might include avoidance, data recovery, and monitoring.

compliance with Stipulations 1.9.1 and 1.9.2 of the Federal Grant and Section 106 of the NHPA would compensate for the inadequacies in the data and provide a measure of protection for any unreported cultural resources that are encountered.

APSC must consult with an archaeologist, as required under Stipulation 1.9.1 of the Federal Grant, and with the Alaska SHPO, as required under Section 106 of the NHPA, regarding any ground-disturbing activities in areas that have not been modified by previous TAPS activities. Under Stipulation 1.9.2 of the Federal Grant, APSC is also required to contact the Authorized Officer and an archaeologist immediately if any known or previously unrecorded archaeological or historical resources are encountered. In addition, the JPO has begun negotiations with the Alaska SHPO to establish a programmatic agreement for the protection of cultural resources along the TAPS.

Specifically with regard to traditional cultural properties, APSC's coordination with the Alaska SHPO and the appropriate Alaska Native groups for the region to be affected, also required under Section 106 of the NHPA (16 USC §470f), would avoid any adverse impacts to traditional cultural properties or establish mitigation measures for such impacts.

The final resource to be considered is the TAPS itself, which may be eligible for listing on the NRHP as a historically significant structure. The TAPS is an example of significant engineering and construction, and it played an important role in the history of Alaska and the United States. The continued operation of the TAPS is unlikely to result in an adverse impact to this potentially significant structure. If any large or central portions of the pipeline were to be dismantled during the 30-year renewal period, APSC would be required to coordinate with the Alaska SHPO under Section 106 of the NHPA (16 USC §470f).

4.3.23 Land Use and Coastal Zone Management

4.3.23.1 Land Use

Only land already within the existing ROW would be needed under the proposal action. Valid legal access for TAPS operation and maintenance exists on all parcels, with one exception currently under negotiation (Hansen 2002). However, repair operations during the renewal period could require authorization to use federal or state public lands or private lands outside the ROW.

Impacts of Proposed Action on Land Use and Ownership

Renewal of the Federal Grant resulting in continued operation and maintenance of the TAPS would be expected to have some impacts on land use along the pipeline. No major additional changes in current land use activities would be expected. However, the Ahtna and Chugach Corporations' concerns about trespassing and land use conflicts, respectively (which they attribute to the existence of the pipeline), could continue if the grant is renewed. Data are inconclusive regarding past, present, and future impacts of the TAPS and related facilities on subsistence activities.

Under the proposed action, some effects on federal, state, and private land use in the vicinity of the pipeline would occur. Historical trends in commercial, municipal, and residential development would be expected to continue. The proposed action would not preclude recreational, wildlife habitat conservation, military, mining, agricultural, or subsistence activities that currently occur in the vicinity of the pipeline. The restrictions on recreational use of the TAPS corridor and access roads across the corridor, which were instituted for security purposes after September 11, 2001, would continue for an unknown period of time. However, some land use conflicts have occurred on Native lands near the pipeline and could continue if the grant is renewed.

Federal and state lands in the vicinity of the pipeline include National Parks; federally designated Wilderness Areas; National Wildlife Refuges; National Wild and Scenic Rivers; and state recreation areas, sites, and parks. These lands are used primarily for recreation, wildlife habitat conservation, subsistence, and protection/preservation of ecological resources. Past operation and maintenance of the TAPS have not interfered with these land uses and have not impacted the protected resources in the ACECs managed by the BLM. Consequently, on the basis of past trends, the proposed action would be unlikely to interfere with or otherwise impact federal or state land uses.

The operation and maintenance of the TAPS also has not interfered with military, mining, or agricultural activities. The pipeline crosses Fort Greely, Eielson Air Force Base, and Fort Wainwright. On the basis of past trends, future interference with these activities would not be likely under the proposed action.

Data are inconclusive regarding past, present, or potential future effects on subsistence from the TAPS and related facilities. Although subsistence hunters have noted some changes in the availability of subsistence resources, attributing those changes to the TAPS is not possible from existing data (see Section 4.3.20).

Some access and use conflicts have occurred (and are continuing) along the southern half of the pipeline on Native lands owned by the Ahtna and Chugach Corporations. The Ahtna Corporation, which owns land south of Paxson, has experienced trespassing, which it attributes to the presence of TAPS access roads near a heavily used snowmachine and ORV use area. Ahtna Corporation believes that snowmachine and ORV users gain entry to Ahtna land via the TAPS access roads (Hart 2002). The Chugach Corporation, which owns land in the Valdez area, is concerned that the existence of the TAPS on their land precludes other uses (Rogers 2002). Continued operation and maintenance of the TAPS could result in continued trespassing on Ahtna land. In addition, the Chugach Corporation's concern about TAPS' preclusion of use on their lands could continue.

Although construction of the 400-mi Dalton Highway (built to service TAPS) has increased access to remote areas north of the Yukon River, the highway would remain whether or not the renewal occurs. Airstrips constructed for TAPS development and maintenance would also likely remain in existence regardless of renewal.

Changes in pump station operations are possible during the renewal period. Some pump stations could be upgraded or removed. One or more tanker berths could also be shut down or removed at the Valdez Marine Terminal. Other than some temporary increase in noise during construction or removal, which could be audible to recreationists, no direct or indirect impacts on land use are anticipated.

Continued operation and maintenance of the pipeline would entail the risk of spills. Spill scenarios for the proposed action and potential impacts on land use are discussed in Section 4.4.4.17.1.

4.3.23.2 Coastal Zone Management

The TAPS ROW begins in the North Slope Borough Coastal Zone and ends in the Valdez Coastal Zone. In compliance with the ACMP, both coastal zones have fully approved CMPs that include enforceable policies to regulate development activities. Activities must also be consistent with applicable ACMP statewide standards. The Alaska Division of Governmental Coordination (ADGC) and State of Alaska resource agencies conduct consistency reviews to ensure that proposed development activities are consistent with existing CMPs. Consistency reviews are conducted on TAPS maintenance activities before they occur (Laughlin 2002; State of Alaska 2001).

The North Slope Borough CMP requires that development activities not substantially interfere with subsistence activities in the borough or jeopardize the continued availability of

TAPS Compliance with Coastal Zone Management Policies

The northern and southern ends of the pipeline pass through the North Slope Borough and Valdez Coastal Zones, respectively. Pipeline operation and maintenance are currently permitted activities consistent with the CMPs for those zones and are in compliance with enforceable policies and applicable ACMP statewide standards. Continued operation and maintenance of TAPS under the proposed action would not be expected to alter this status.

subsistence resources (North Slope Borough 1988). ACMP consistency reviews are conducted by the ADGC and State of Alaska resource agencies to ensure that the operation and maintenance of the TAPS are consistent with the North Slope Borough CMP and in compliance with enforceable policies as well as applicable ACMP statewide standards. Because of the lack of substantial impacts on subsistence to date and documented compliance with the North Slope Borough CMP and ACMP statewide standards, it is expected that the continued operation and maintenance of the TAPS would not substantially interfere with subsistence activities within the coastal zone or jeopardize subsistence resources.

The Valdez CMP allows for a variety of development activities in the coastal zone, including utility corridors, and prioritizes water-related or water-dependent activities (Valdez 1987). ACMP consistency reviews are conducted by the ADGC and State of Alaska resource agencies to ensure that the operation and maintenance of the TAPS and related facilities, including the Valdez Marine Terminal, are permitted activities consistent with the Valdez CMP and in compliance with enforceable policies, as well as applicable ACMP statewide standards. On the basis of past compliance, it is expected that the continued operation and maintenance of the TAPS would continue to be consistent with the Valdez CMP and in compliance with its enforceable policies and ACMP statewide standards.

Changes in pump station operations are possible during the renewal period. Some pump stations could be upgraded or removed. One or more tanker berths could also be shut down or removed at the Valdez Marine Terminal. Other than some temporary increase in noise during construction or removal, no direct or indirect impacts within the North Slope Borough or Valdez coastal zones are anticipated.

Continued operation of the TAPS would involve the risk of an oil spill that could affect coastal resources. Both the North Slope Borough and Valdez CMPs recognize this risk and require oil spill prevention and response plans consistent with the statewide ACMP standards (see Section 4.4.1) (North Slope Borough 1988; TAPS Owners 2001a). The North Slope Borough CMP also requires risk analyses for various spill scenarios (North Slope Borough 1988). The TAPS is in compliance with these requirements. Spill scenarios for the proposed action and potential impacts on coastal zones are discussed in Section 4.4.4.17.2.

4.3.24 Recreation, Wilderness, and Aesthetics

4.3.24.1 Recreation

The proposed action would likely cause some effects on recreation on federal or state lands in the vicinity of the pipeline. Existing access to public lands would remain. The current restrictions on access to the ROW corridor would continue for an unknown period of time. On federal lands, the current recreational opportunities and the trend of increased use in the vicinity of the pipeline would continue. However, recreational opportunities and use levels would be expected to decline at state recreation areas, sites, and parks as a result of decreased state funding due to declining oil revenues during the 30-year renewal period (see Section 4.3.19).

The construction of the Dalton Highway, which was an indirect effect of the construction of the TAPS, has resulted in increased access to public lands north of the Yukon River, an

Impacts of Proposed Action on Recreation, Wilderness, and Aesthetics

Although no new impacts would result from renewal of the Federal Grant, impacts that have occurred over the past 25 years would likely continue. Increased recreational opportunities and use of public lands along the length of the pipeline would be expected to continue. The current security restrictions on recreational use of the ROW would continue for an unknown period of time.

The current views of the pipeline from the easternmost ridges in the Wilderness Area within the Gates of the Arctic NPP would remain. Noise from vehicular traffic on the Dalton Highway and aircraft traffic along the ROW would continue to be heard from ridgelines along the eastern boundary of the Wilderness Area.

The existing aesthetic impacts from the TAPS and related structures would continue. A temporary increase in impacts would occur in localized areas during pump station upgrading or removal or during the removal of one or more tanker berths at the Valdez Marine Terminal. After completion of removal activities, the visual impact would be diminished in those areas. Because of variations in aesthetic perceptions and values, some visitors might have an adverse reaction to views of the TAPS and related facilities, while others would not.

increase in recreational opportunities, and a small increase in recreational use in some areas (BLM 2001b). Whether or not the TAPS ROW grant is renewed, the Dalton Highway would remain open to the public. The airports near the TAPS ROW corridor would also likely remain operational and continue to provide air access to remote recreation areas (TAPS Owners 2001a). Consequently, since the current road and air access would continue regardless of renewal, the historical trend of increased recreational opportunities and use in some areas would also be expected to continue.

On BLM lands along the Dalton Highway and the TAPS ROW corridor, the current recreational opportunity spectrum classes of roaded natural, roaded modified, and rural would remain under the proposed action, along with their associated management objectives. The past trend of an increasing number of visitors at Coldfoot Visitor Center, Marion Creek Campground, and the Yukon Crossing Contact Station would likely continue. Gates of the Arctic NPP, including the Wilderness Area within it, and the Arctic, Yukon Flats, and Kanuti National Wildlife Refuges all have experienced a small increase in recreational use in the last 25 years that would also be expected to continue under the proposed action. The trend of increased use at White Mountains National Recreation Area would also likely continue. However, decreased use would likely occur at some state recreation areas, sites, and parks because of reduced state funding, which could result in closure of some of these state facilities.

The Richardson Highway, which existed as a paved highway decades before the construction of the TAPS, would continue to provide access to public lands in the vicinity of the southern half of the TAPS. Under the proposed alternative, the BLM would likely continue to manage for the roaded natural, semiprimitive motorized, and semiprimitive nonmotorized recreational opportunity spectrum classes currently available on BLM lands along the southern half of the pipeline.

Currently existing recreational opportunities on the Delta and Gulkana National Wild and Scenic Rivers (WSRs) would not be affected by the proposed action. The grant renewal would not interfere with the objectives of the BLM's river management plans (BLM 1983a,b) and would not entail construction of any impoundments, structures, or diversions on either river (TAPS Owners 2001a). Increased recreational use of both WSRs would be expected to continue.

Because Wrangell-St. Elias NPP has not documented an increase in use during the last 25 years, implementation of the proposed action alternative would not be expected to affect future use. On the basis of past trends, the amount of recreational use at Chugach National Forest (near the Valdez Marine Terminal) would also likely be unaffected by the TAPS ROW renewal. Use levels at state recreation areas, sites, and parks along the southern half of the pipeline would be expected to continue. Current recreational opportunities would continue at Wrangell-St. Elias NPP, the Chugach National Forest, and undeveloped state lands.

APSC visitor sites and viewing stations along the length of the pipeline that are currently open would likely remain open to the public throughout the renewal period, although additional closures could occur if deemed necessary for security. The current ban on recreational use of the TAPS corridor, in effect since September 11, 2001 (Stearns 2002), would continue for an unknown period of time.

Changes in pump station operations would be possible during the renewal period. Some pump stations could be upgraded or removed. One or more tanker berths could also be shut down or removed at the Valdez Marine Terminal. Other than some temporary increase in dust and noise from machinery and traffic during construction or removal, no other impacts would be anticipated.

4.3.24.2 Wilderness

No federal or state designated or proposed Wilderness Areas exist within or adjacent to the TAPS ROW corridor (ADNR 2001d; APSC 1993; Delaney 2001). The Wilderness Area within Gates of the Arctic NPP is the only federally designated Wilderness Area within a few miles of the TAPS. Its eastern boundary is within 2 to 3 mi of the TAPS at its closest point (Ulvi 2001).

Under the proposed action, indirect effects on the Wilderness Area within Gates of the Arctic NPP would continue. No impacts would likely occur to the values that qualify it for wilderness designation. The pipeline is visible from some points along the easternmost ridges in the Wilderness Area, but that impact on the viewshed did not preclude wilderness designation in 1980. Although increased access to the vicinity of the TAPS has occurred from construction of the Dalton Highway and airports within the TAPS corridor, the National Park Service has noted only a slight increase in recreational use in the eastern portion of the Wilderness Area (Ulvi 2001). This use trend would likely continue under the proposed action.

Vehicular traffic from the highway and aircraft traffic along the TAPS corridor can be heard from ridgelines along the eastern Wilderness Area boundary. However, this small, localized impact did not preclude wilderness designation in 1980. Even without the renewal of the TAPS, some noise would continue to be heard along the eastern boundary of the Wilderness Area because the Dalton Highway would remain open to the public. In addition, noise from snowmachines, motorboats, and airplanes currently and historically used within the Wilderness Area would continue. Such usage is allowed in Alaskan Wilderness Areas pursuant to provisions of the ANILCA of 1980.

Whether or not the Federal Grant is renewed, the pipeline corridor does not meet the criteria for federal wilderness designation as defined by the Wilderness Act of 1964. Both the TAPS corridor and adjacent areas have been altered by man and do not offer outstanding opportunities for solitude and primitive recreation because of the proximity of the highways. Since the areas do not meet these essential criteria, federal wilderness designation is not possible. Consequently, the proposed action would not affect the suitability of the TAPS corridor for wilderness designation.

The existence of the TAPS has not precluded state designations of wilderness in Alaska in the vicinity of the pipeline. Implementation of the proposed action would not affect the potential for future designations.

Changes in pump station operations would be possible during the renewal period. Some pump stations could be upgraded or removed. Because of the distance between the nearest pump station and Gates of the Arctic NPP Wilderness Area, no direct or indirect impacts on wilderness are anticipated.

The continued operation and maintenance of the TAPS would entail the risk of a spill. It is unlikely that a TAPS spill would affect the Gates of the Arctic NPP Wilderness Area because of its distance from the pipeline. Spill scenarios for the proposed action and potential impacts on wilderness are discussed in Section 4.4.4.18.2.

4.3.24.3 Aesthetics

The TAPS ROW passes through areas that contain outstanding visual resources. About half the 800-mi length of the TAPS is above ground and clearly visible from the air. Most of the above-ground segments, including pump stations and related structures, also are visible from adjacent public roads. The pipeline is within sight of some BLM and state recreation sites and is visible from ridgelines along the eastern boundary of the Wilderness Area within Gates of the Arctic NPP. The TAPS is also visible from some BLM-managed ACECs and at a few points within the Delta and Gulkana National Wild and Scenic River corridors, including where the pipeline is suspended above the Gulkana River. The pipeline is also suspended above the Tanana River within sight of the Richardson Highway and above the Yukon River on the same bridge that carries the Dalton Highway. In addition, the Valdez Marine Terminal is clearly visible from the City of Valdez (TAPS Owners 2001a; APSC 1993). These localized existing aesthetic impacts would continue under the proposed action.

Occasional and temporary visual air impacts have occurred in the past during tank-vent flaring at PS 1. However, testing conducted since the completion of recent flare upgrades indicates that even vapor generation from a full pipeline inrush does not cause opacity. Consequently, emission impacts near PS 1 would likely either not occur or occur only very infrequently under the proposed action (Devereux 2001).

The entire TAPS corridor is managed by the BLM for energy transportation according to Class IV VRM objectives that allow major modifications to the existing landscape. Efforts are made to minimize visual impacts, particularly to ACECs and WSRs (BLM 1989; Overbaugh 2001). Stipulations in the Federal Grant also include provisions intended to minimize visual impacts.

Because perception of aesthetics involves a value judgment, some visitors might have an adverse reaction to views of the TAPS and related facilities, while others would not. Because of mitigation, ROW stipulations, and variations in aesthetic perceptions and values, only intermittent and localized impacts to visual resources would be expected to occur under routine operations.

APSC viewing stations along the length of the pipeline that are currently open would likely remain open to the public throughout the renewal period, although additional closures could occur if deemed necessary for security. The current ban on recreational use of the TAPS corridor, in effect since September 11, 2001 (Stearns 2002), would continue for an unknown period of time.

Changes in pump station operations would be possible during the renewal period. Some pump stations could be upgraded or removed. One or more tanker berths could also be shut down or removed at the Valdez Marine Terminal. A temporary and localized increase in the currently existing aesthetic impact would occur during upgrade or removal activities due to the presence of machinery and personnel and a potential increase in dust in some locations. However, the long-term aesthetic impact would decrease somewhat in areas where pump stations were removed, although visual evidence of the former presence of the pump station would likely remain.

Continued operation and maintenance of the TAPS would entail the risk of an oil spill that could potentially affect visual resources in the vicinity of the pipeline. Spill scenarios for the proposed action and potential impacts on aesthetics are discussed in Section 4.4.4.18.3.

4.3.25 Environmental Justice

The environmental justice analysis rests primarily on Executive Order 12898, which establishes the need to consider high and adverse impacts to minority and low-income populations. However, the relatively large proportion of Native (indigenous) peoples residing in Alaska and relying on subsistence provides a much more complex setting than most in which environmental justice is evaluated. A number of steps during the preparation of this DEIS provided an improved understanding of Alaska Native issues, including the challenges associated with evaluating environmental justice impacts.

Environmental Justice under the Proposed Action

In the absence of the identification of high and adverse effects in any particular impact area, no negative environmental justice impacts would be expected. Possible positive impacts for minority populations would be:

- Disproportionately high access to the Permanent Fund Dividend, because of their larger families compared with the population as a whole; and
- Base-level employment for Alaska Natives with APSC at 20% of total hires, which is slightly greater than Alaska Native representation in the state population.

Executive Order 13175, "Consultation and Coordination with Indian Tribal Governments," requires that the federal government consult with Tribal governments during the preparation of an EIS. As the lead federal agency associated with the EIS, the BLM established government-to-government exchanges with all Tribal governments in Alaska and more focused exchanges with 21 tribes directly affected by the TAPS (BLM 2001a). A number of steps were taken to establish these relationships. Initially, certified letters were mailed to all Tribal governments in Alaska recognized by the Bureau of Indian Affairs, informing them of the anticipated application to renew the Federal Grant. A systematic evaluation of Tribal peoples in the vicinity of the TAPS led to the identification of 16 directly affected communities (BLM 2001a); 5 additional groups were subsequently added, bringing the total to 21. These 21 communities received more detailed mailings explaining the ROW renewal, the EIS process, and the various sources of additional information. Meetings were held with a number of Tribal organizations, representing single Native groups as well as combinations of groups, to discuss the EIS process and related issues in greater detail (Table 4.3-22).

In addition to government-to-government interaction, several other steps have been taken to integrate Alaska Natives within the EIS process. One of the most important was the addition of an Alaska Native to the JPO staff to serve as liaison with Tribal peoples before the onset of the EIS process. Although only one scoping meeting took place in a predominantly Alaska Native community, the remaining five occurred in communities that featured large numbers of Natives in residence or nearby. EIS staff attended key Alaska Native meetings, such as the Alaska Inter-Tribal Council and Alaska Federation of Natives meetings in fall 2001. Efforts taken to establish and maintain government-to-government interchanges during various stages of the EIS process helped to improve information exchange as well as interpretations of impacts under environmental justice and other impact areas related to Alaska Natives.

As stated above, environmental justice concerns require the presence of high and adverse impacts. As discussed in detail throughout Section 4.3, evaluations of anticipated environmental consequences of the proposed action do not indicate the presence of high and adverse impacts under normal operating conditions of the TAPS (Table 4.3-23). In the absence of such consequences, no negative environmental justice impacts are expected, regardless of the presence of disproportionately high percentages of minority and low-income populations in areas that might experience effects from the TAPS (see Section 3.29).

In contrast, certain disproportionately positive impacts likely will affect environmental justice populations under the proposed action. One of the most obvious is the Permanent Fund Dividend, which is paid to every eligible citizen of Alaska. Although data on average family size for minorities as defined in this document are unavailable from the 2000 census, the fact that the average size of White families (3.13 persons) is smaller than the average size of families in the state of Alaska as a whole (3.28 persons) indicates that the average size of non-White

TABLE 4.3-22 Government-to-Government Interaction Summary

Activity	Period in Renewal Process	Date
Sent certified mailings to all Alaska Tribes	Pre-application	April 26, 2001
Met with Alaska Native representatives in Chenega, Tatitlek, and Valdez	Pre-application	May 12, 2001
Met with Copper River Native Association	Pre-application	May 18, 2001
Met with Tribal/First Nations Oil and Gas Coalition	Pre-application	May 21, 2001
Sent certified mailings to directly affected tribes	Application review	May 25, 2001
Met with AFN and TAPS Owner representatives	Application review	June 13, 2001
Mailed background information packets to Tanana Chiefs	Application review	June 20, 2001
Met with Tanana Chiefs Conference	Application review	July 1, 2001
Met with Copper River Native Association chiefs	Application review	July 16,2001
Sent certified letters to directly affected Tribes re: scoping	Application review	Aug. 3, 2001
Mailed letter to Copper River Native Association with information on TAPS renewal	Application review	Aug. 6, 2001
Mailed letter to Mentasta Tribal Council re: consultation on directly impacted status in TAPS renewal	Application review	Aug. 7, 2001
Mailed letter to N. Cesar, Bureau of Indian Affairs, re: public scoping for TAPS Renewal EIS	Application review	Aug. 16, 2001
Contacted each directly affected Tribe by telephone to see if there were questions about renewal or EIS process	EIS scoping period	Aug. 2001
Met with Alaska Inter-Tribal Council Staff	Application review	Sep. 30, 2001
Met with Allakaket Village representatives	EIS scoping period	Sept. 5, 2001
Met with Minto Village representatives	EIS scoping period	Sept. 6, 2001
Mailed letter to Qutecak Native Council re: invitation to participate in public scoping for TAPS Renewal EIS	EIS scoping period	Sept. 6, 2001
Sent letter to Tanana Tribal Council re: directly and substantially impacted status in TAPS Renewal EIS	EIS scoping period	Sept. 21, 2001
Met with Nuiqsut Village representatives	EIS scoping period	Sept. 24, 2001
Met with Eyak Village representatives	EIS scoping period	Sept. 27, 2001
Met with Tazlina Tribal Council	EIS scoping period	Oct. 2, 2001
Sent letter to Mentasta Traditional Council re: TAPS Renewal EIS	EIS scoping period	Oct. 2, 2001
Met with Chugach Regional Corporation to discuss TAPS renewal process	EIS scoping period	Oct. 2, 2001
Met with Alaska Inter-Tribal Council to discuss TAPS renewal process	EIS scoping period	Oct. 11, 2001
Met with Regional Advisory Councils to discuss TAPS renewal process	EIS scoping period	Oct. 11, 2001

TABLE 4.3-22 (Cont.)

Activity	Period in Renewal Process	Date
Conducted public scoping meeting for EIS in Barrow	EIS scoping period	Oct. 12, 2001
Sent letter to Stevens Village IRA Council to discuss TAPS renewal process	EIS preparation period	Dec. 3, 2001
Sent certified mailings to directly affected Tribes transmitting report summarizing results of public scoping for TAPS Renewal EIS	EIS preparation period	Dec. 21, 2001
Communicated (Argonne National Laboratory) with Native Village of Eklutna re: Alaska Inter-Tribal Council resolution to establish trust fund related to the TAPS	EIS preparation period	Jan. 8, 2002
Sent letter to Native Village of Eklutna re: Alaska Inter-Tribal Council public scoping comments	EIS preparation period	Jan. 8, 2002
Sent letter to Tanana Chiefs Conference re: request for cooperating agency status	EIS preparation period	Jan. 16, 2002
Sent letter to Bureau of Indian Affairs re: Native allotments and the TAPS Renewal EIS	EIS preparation period	March 8, 2002
Sent certified letters (Argonne National Laboratory) to directly affected Tribes re: traditional knowledge and its role in the TAPS Renewal EIS	EIS preparation period	April 3, 2002
Met with AFN representatives to discuss approach to subsistence analysis in the TAPS Renewal EIS	EIS Preparation period	April 17, 2002
Sent certified letters to directly affected Tribes inviting participation in meetings to discuss TAPS Renewal EIS issues of particular interest to Alaska Natives before release of DEIS; facilitated workshops to help organize and submit comments on the DEIS; and held public hearings on the DEIS	EIS preparation period	April 25, 2002
Met with representatives of directly affected Tribes to discuss issues covered in the DEIS and the process of commenting on the draft document	EIS preparation period	June 4, 5, and 6, 2002

families would have to exceed 3.28 (to bring the average to 3.28) (U.S. Bureau of the Census 2002b). Minority families therefore would experience more financial benefits per family than nonminority families in the state. Moreover, the Permanent Fund Dividend tends to contribute a larger percentage of the income of minority populations (who tend to have lower incomes than nonminorities) and low-income families than of other families in Alaska. As a result, continuation of the dividend under the proposed action would provide disproportionately greater financial benefits for environmental justice populations than for the state population as a whole. Another disproportionately positive impact affecting Alaska Natives would occur under Section 29 of the Federal Grant, establishing a base level of Alaska Native employment with APSC at 20% of total hires — 1.3% higher than the percentage of Alaska Natives in the state (see Section 3.25.1).

TABLE 4.3-23 Summary of Anticipated Impacts Under the Proposed Action

Issue Area	DEIS Section	Summary of Impacts[a]
Physiography and geology	4.3.1	Anticipated negative impacts would be localized and small.
Soils and permafrost	4.3.2	Anticipated negative impacts would be localized and small; earthquake-triggered liquefaction could threaten the integrity of the TAPS, causing spills, but would be highly unlikely.
Seismicity	4.3.3	No anticipated negative impacts on the basis of earthquakes that have occurred since TAPS construction; soil liquefaction and landslides due to an extremely large earthquake could threaten the integrity of the TAPS, although the likelihood of this happening is unknown.
Sand, gravel, and quarry resources	4.3.4	Anticipated negative impacts would be localized and small.
Paleontology	4.3.5	No anticipated negative impacts.
Surface water resources	4.3.6	Both anticipated direct and indirect negative impacts would be localized, small, and temporary.
Groundwater resources	4.3.7	Both anticipated direct and indirect negative impacts would be localized.
Physical marine environment	4.3.8	Anticipated negative impacts may affect the physical marine environment, but at acceptable levels similar to those already experienced under normal TAPS operations (and likely at lower levels because of decreased throughput and improved waste treatment).
Air quality	4.3.9	Anticipated negative impacts are expected to lie within regulatory limits established for the TAPS and within both federal and state ambient air quality standards.
Noise	4.3.10	Anticipated negative impacts likely would be similar to those currently experienced in TAPS operations; negative impacts from construction and maintenance would be greater than normal current levels, but temporary and localized; negative impacts on animals from flyovers would be localized.
Transportation	4.3.11	No anticipated negative impacts.
Hazardous materials and waste management	4.3.12	Anticipated negative impacts would be similar to those currently experienced, with the management of hazardous materials and waste occurring in accordance with existing permits and regulations.

TABLE 4.3-23 (Cont.)

Issue Area	DEIS Section	Summary of Impacts[a]
Human health and safety	4.3.13	Anticipated negative impacts to workers, including fatalities, injuries, and time lost due to injuries, all are of a magnitude similar to rates observed by the Bureau of Labor Statistics and the National Safety Council; anticipated negative impacts to the public would be small.
Biological resources	4.3.14 (Biological Resources Overview), 4.3.15 (Terrestrial Vegetation and Wetlands), 4.3.16 (Fish), 4.3.17 (Birds and Terrestrial Mammals), and 4.3.18 (Threatened, Endangered, and Protected Species)	Anticipated negative impacts to vegetation would be small and localized; anticipated negative impacts to fish would be small and temporary, with no population-level impacts; anticipated negative impacts to birds and terrestrial mammals would be small and localized, with no population-level impacts; anticipated negative impacts to threatened, endangered, and protected species are not expected to exceed population-level impacts accompanying natural variation.
Economics	4.3.19	Anticipated impacts include slow-to-moderate growth of gross state product, population, employment, personal income, and tax revenues over the renewal period.
Subsistence	4.3.20	Anticipated impacts would include both positive and negative effects, the former improving subsistence (e.g., access to better technology for harvesting fish and game) and the latter reducing it (e.g., continued TAPS-related traffic on the Dalton Highway possibly disrupting migrations); overall impact likely would be negative but small.
Sociocultural systems	4.3.21	Anticipated impacts would include both positive and negative effects; overall impact likely would be negative but small.
Cultural resources	4.3.22	Any possible negative impacts would be mitigated through procedures developed in consultation with the Alaska SHPO.
Land use and coastal zone management	4.3.23	Anticipated impacts on land use and land ownership are expected to be minor; anticipated impacts on coastal zone management are expected to remain in compliance with enforceable policies and applicable statewide standards.
Recreation, wilderness, and aesthetics	4.3.24	Anticipated impacts to recreation, wilderness, and aesthetics are expected to continue those already occurring, all of which are within acceptable levels.

[a] Impacts are summarized here for the convenience of the reader. Details of the impact evaluations could not be included because of space limitations; additional information for each issue area may be found in the referenced DEIS section.

4.4 Spills Analysis for Proposed Action

4.4.1 Spill Scenarios

The prevention of a release or spill of petroleum products is inherent to the design of pipeline systems. Once the pipeline is operating, monitoring pipeline fluid flow parameters, instituting operational procedures and controls, and performing periodic maintenance procedures are typically used as industry spill prevention best practices. Spill prevention and response requirements specific to the TAPS are discussed in Section 4.1.4. As with all engineered systems, including pipelines, process or material failures and human error leading to material loss are expected occurrences. The environmental consequences from these occurrences, such as an accidental spill, cannot be evaluated without reference to a known or expected release of a specific size, location, and duration. The pipeline spill scenarios that have been developed for this spill analysis represent "credible" potential pipeline events, as defined in Appendix A, Section A.15, for use in assessing impacts from accidental releases or spills during TAPS operations.

The spill scenario environmental impacts assessed under the proposed action in this DEIS do not imply that these spills are "expected" pipeline events. In addition, a spill that actually occurs may or may not occur in the same sequence or combination of events as specified in the assessed spill scenarios. An underlying principle in this spills analysis is that conditions constantly change along the length of the TAPS. The spill volume and frequency vary as a function of milepost along the TAPS because of (1) varying conditions external to the pipeline system, such as topography, soil conditions, potential for damaging earth movements, and potential for third-party damages; and (2) varying pipeline system characteristics, such as pipe type, coating condition, operating pressures, maintenance practices, and types and dates of integrity validations. This spills analysis, therefore, considers the location-specific interaction of all critical variables in all failure modes, including to the extent possible, any risk-reducing measures taken by the operator.

Spills Analysis and Impact Definitions

A *spill scenario* is a description of a possible spill event, including the cause (e.g., earthquake), damage to containment vessel (e.g., crack in pipeline), the material and quantity spilled (e.g., crude oil), the location (e.g., MP 45), and how frequently such a spill would be expected to occur.

Spill frequency is a quantitative expression of the likelihood of a particular petroleum spill scenario. For example, if a corrosion leak along the length of the pipeline has a frequency of 1×10^{-3}/yr, this implies that a leak due to corrosion is expected to occur with a frequency of once in 1,000 years.

Spill volume is the quantity, usually expressed in barrels or gallons, of material released to the natural environment (e.g., escaping to soil outside of the facility).

Consequence is the associated impact on humans and/or the natural environment as a result of the release of material on soil, and/or into water and/or the air.

Risk is the product of the spill consequence and the associated frequencies. An example would be the risk associated with the frequency of occurrence of a sequence of events leading to the release, exposure, and resulting damaging effect on humans (e.g., second degree burn or lung damage) and the environment (e.g., loss of moose habitat).

This spill analysis focuses on potential spills associated with continued operation and maintenance of the TAPS from 2004 through 2034. Review of existing spill records contained in the TAPS Spills Database (TAPS Owners 2001b) established that the spills analysis should consider crude oil, gasoline, diesel fuel, and turbine fuel, on the basis of the projected continued pipeline transport and use of these materials in TAPS facility operations. The potential environmental impacts of the various types of petroleum products, such as gasoline and diesel fuel, are another measure by which the various petroleum products were considered for inclusion in the spills analysis. The TAPS pioneered the use of drag reducing agent, a long-chain hydrocarbon polymer injected into the pipeline to reduce pipeline friction and turbulent flow energy losses. Spills of drag reducing agent were discounted because of its high viscosity, slow environmental mobility, and relatively low toxicity compared with the petroleum spills covered by the analysis.

Potential spill scenarios were developed by using available literature concerning current TAPS operations (APSC 2001m; Capstone 2001; ARRT 2000). Recent NEPA documents for other pipeline projects (USFS and WEFSEC 1998; USFS 1999; CPUC and USFS 1996; CPUC 1998) were also reviewed to ensure consideration of a wide spectrum of spill scenarios consistent with current industry practice.

The severity and overall risk to the environment from petroleum product spills are direct functions of the following factors:

- Type of petroleum product spilled;
- Location, duration, and size of the spill;
- Frequency of spill events;
- Time of the year or the season in which the spill occurs;
- Local environmental conditions (e.g., wind or river speed, surface roughness, and porosity) at the time and place of the spill;
- Location and susceptibility of downtream or downwind receptors; and
- Effectiveness of emergency response and cleanup measures.

The first three factors, as they relate to the spill scenarios, are briefly discussed below, followed by identification and description of the spill events used in this analysis and their consideration in developing the spill scenarios. The last four factors are more related to the assessment of environmental impacts and are covered in the relevant consequence sections of this document.

The influence on the severity of impacts because of local conditions, receptor susceptibility, and effectiveness of emergency response measures is discussed in Sections 3.12, 4.4.4.9 through 4.4.4.12, and 3.1.2.1.6, respectively. The type and the associated characteristic properties of crude oil, refined petroleum, and the associated hazard materials used or generated as waste during TAPS operations were carefully considered in developing release scenarios that could pose a potential harm to the environment. These characteristics are discussed in further detail in Appendix A, Section A.15.

4.4.1.1 Pipeline and Valdez Marine Terminal Spill Scenarios and Locations

The developed spill scenarios took into account spill location, duration, magnitude, and frequency. Sensitive receptor locations and environmental media, such as rivers and streams, serving as spill transport-enhancing media to a sensitive receptor were identified as impacting factors along the pipeline. The spill magnitude and duration were computed in defining each spill scenario. Although large spills of relatively short duration may impose large to catastrophic environmental consequences, relatively long duration spills with release rates too small for detection with current technology could also pose large environmental consequences. Considering the extremely small frequencies of very large spills, such spills would be expected to represent a relatively small environmental risk (which takes into account frequency as well as consequence).

Frequency of occurrence, the fourth factor in the risk severity equation, allows the estimated environmental consequences from spill events to be put into perspective relative to likelihood of occurrence. The various spill scenarios developed for assessment in this DEIS are forecast to occur at frequencies ranging from several times a year to once in 1 million years. In general, the greater the volume of material released and the greater the expected consequences, the more unlikely it would be for a spill to occur (the lower its probability). As discussed for the spills analysis methodology in Appendix A, Section A.15, each spill scenario was assigned to one of the following four frequency categories: *anticipated, likely, unlikely,* and *very unlikely*. The spill analysis computed frequencies for each pipeline scenario, and each scenario was assigned a likelihood category with frequency ranges given below:

- *Anticipated:* Spills estimated to occur one or more times every 2 years of TAPS operations (frequency ≥ 0.5 per year).
- *Likely:* Spills estimated to occur between once in 2 years and once in 30 years of TAPS operations (frequency = from 0.5 per year to 0.03 per year).
- *Unlikely:* Spills estimated to occur between once in 30 years and once in 1,000 years of TAPS operations (frequency = from 0.03 per year to 1×10^{-3} per year).
- *Very Unlikely:* Spills estimated to occur between once in 1,000 years and once in 1 million years of TAPS operations (frequency = from 1×10^{-3} per year to 1×10^{-6} per year).

The first two likelihood categories listed above have frequencies consistent with the historical operation of the TAPS, starting when the pipeline first began pumping crude oil from the North Slope on June 20, 1977. The 30- to 1,000-year range given for the third frequency category represents events that would be unlikely to occur within the renewal period of the TAPS. The once in a thousand year frequency boundary between the unlikely and very unlikely categories was set to be consistent with the TAPS design basis envelope (APSC 1996). The once in a million years frequency is set as the boundary between very unlikely events and events considered incredible.

Estimated pipeline spill frequencies for pipeline operations for each spill scenario were derived from data compiled from a number of available sources. Data on small- to moderate-sized spills with anticipated to likely frequencies were collected for all of the recorded spills that have occurred on the entire TAPS pipeline system over the 25 years from January 1977 to November 2001 (TAPS Owners 2001b). Frequencies for likely events also included data from DOT domestic natural gas transmission and gathering lines (DOT 2001a,b), and DOT domestic hazardous liquid pipelines (DOT 2001c). The spills analysis contained in the TAPS ROW Environmental Report (TAPS Owners 2001a) was used as an aid in identifying major spill events and in evaluating statistical distributions for the historical TAPS spill record.

Leaks resulting in pipeline spills may range from a small leak, where oil escapes the pipeline for an extended period of time until detected, to a large pipeline rupture, where crude oil is released into the environment over a relatively short time but in potentially large quantities. The volume of a leak depends on the size of the opening in the pipe, the crude oil density, the pipeline pressure, topography, and leak duration. The spill volumes for each scenario were determined by the duration of the release multiplied by the flow rate through an assumed hole size (barrels or gallons per hour), and the line draindown volume subsequent to shutdown of the line. The spill duration accounts for the time required to detect a leak, locate it if it is not immediately obvious, and shut down the pipeline (Capstone 2001). The draindown volume is the estimated quantity of crude oil that could be released from a pipeline rupture on the basis of topography, pipeline diameter, pressure, valve location, and response time.

The TAPS pipeline and Valdez Marine Terminal spill scenarios considered in this DEIS are outlined in Tables 4.4-1 and 4.4-2, respectively. One of three spill release duration ranges is assigned to each spill scenario identified in the tables. If a release is estimated to occur very quickly, with duration on the order of 1 hour or less, it is designated as an instantaneous release. Short duration releases are assumed to occur over periods of a few hours up to a day, and prolonged releases are assumed to take place over several days to several months.

TABLE 4.4-1 Summary of Spill Scenarios for Continued Operation of the TAPS Pipeline

			Frequency Range				Release (spill) Characteristics			
Scenario No.	Scenario Description	Expected Frequency (per yr)	Anticipated (> 0.5/yr)	Likely (0.03 to 0.5/yr)	Unlikely (10^{-3} to 0.03/yr)	Very Unlikely (10^{-6} to 10^{-3}/yr)	Crude/ Oil Products	Spill Volume (bbl)	Release Point[a]	Release Duration[b]
1	Small leak of crude oil during pipeline or pump station operations	> 0.5	X				Crude oil	0 – 50	Above or below ground	Instantaneous
2	Small leak of diesel fuel during pipeline or pump station operations	> 0.5	X				Diesel fuel	0 –100	Above ground	Instantaneous
3	Small leak of gasoline during pipeline or pump station operations	> 0.5	X				Gasoline	0 – 3	Above ground	Instantaneous
4	Small leak of turbine fuel during pipeline or pump station operations	> 0.5	X				Turbine fuel	0 – 50	Above ground	Instantaneous
5	Moderate leak of crude oil during pipeline or pump station operations	0.5 – 0.03		X			Crude oil	50 – 1,800	Above or below ground	Instantaneous
6	Moderate leak of diesel fuel during pipeline or pump station operations	0.5 – 0.03		X			Diesel fuel	100 – 200	Above ground	Instantaneous
7	Moderate leak of gasoline during pipeline or pump station operations	0.5 – 0.03		X			Gasoline	3 – 100	Above ground	Instantaneous
8	Moderate leak of turbine fuel during pipeline or pump station operations	0.5 – 0.03		X			Turbine fuel	50 – 200	Above ground	Instantaneous

TABLE 4.4-1 (Cont.)

Scenario No.	Scenario Description	Expected Frequency (per yr)	Frequency Range: Anticipated (> 0.5/yr)	Likely (0.03 to 0.5/yr)	Unlikely (10^{-3} to 0.03/yr)	Very Unlikely (10^{-6} to 10^{-3}/yr)	Release (spill) Characteristics: Crude/ Oil Products	Spill Volume (bbl)	Release Point[a]	Release Duration[b]
9	Leak due to maintenance-related damage	4.0×10^{-2}		X			Crude oil	50 – 5,000	Above or below ground	Very Short
10	Leak due to overpressurization from inadvertent RGV closure	3.2×10^{-2}		X			Crude oil	1,000 – 3,000	Above or below ground	Short (hours)
11	Valve leak due to gasket failure or large packing leak	1.6×10^{-2}			X		Crude oil	1,000 – 10,000	Above ground	Prolonged (days)
12	Leak due to sabotage or vandalism	4.8×10^{-2}		X			Crude oil	900 – 10,000	Above ground	Prolonged (days)
13	Leak due to washout damage resulting from close proximity to a stream or river	5.4×10^{-4}				X	Crude oil	700 – 10,000	Above ground	Prolonged (days)
14	Leak due to corrosion-related damage	3.8×10^{-2}		X			Crude oil	200 – 10,000	Above or below ground	Prolonged (days)
15	Leak due to pipeline settlement (subsidence)	7.4×10^{-3}			X		Crude oil	50 – 5,000	Below ground	Short (hours)
16	Crack resulting from seismic fault displacements and ground waves	1.4×10^{-2}			X		Crude oil	3,000 – 16,000	Above or below ground	Short (hours)
17	Tank loss at TAPS pump station	1.1×10^{-5}				X	Crude oil	700	Above ground, on land, outside containment	Short (hours)

TABLE 4.4-1 (Cont.)

Scenario No.	Scenario Description	Expected Frequency (per yr)	Frequency Range: Anticipated (> 0.5/yr)	Likely (0.03 to 0.5/yr)	Unlikely (10^{-3} to 0.03/yr)	Very Unlikely (10^{-6} to 10^{-3}/yr)	Release (spill) Characteristics: Crude/ Oil Products	Spill Volume (bbl)	Release Point[a]	Release Duration[b]
18	Guillotine break due to impact of a large truck (18-wheeler)	1.7×10^{-4}				X	Crude oil	2,000 – 5,000	Above ground	Short (hours)
19a	Guillotine break due to aircraft crash without fire	8.6×10^{-3}			X		Crude oil	2,000 – 54,000	Above ground	Short (hours)
19b	Guillotine break due to aircraft crash with fire	2.6×10^{-3}			X		Crude oil	2,000 – 54,000	Above ground	Short (hours)
20	Guillotine break due to landslide (e.g., seismic initiated)	8.0×10^{-3}				X	Crude oil	2,500 – 47,000	Above or below ground	Short (hours)
21	Guillotine break due to impact of a helicopter	2.9×10^{-5}				X	Crude oil	2,000 – 54,000	Above ground	Short (hours)

[a] See Table 4.4-5 for the surface water bodies that guillotine break spills would be expected to reach. Depending upon terrain features and spill proximity, smaller spills may also reach surface water bodies. See Sections 4.4.4.3 and 4.4.4.4 for discussion of spill impacts on surface water and groundwater resources.

[b] An instantaneous release is defined as a final spill of duration on the order of 1 hour or less.

TABLE 4.4-2 Summary of Spill Scenarios for Continued Operations of the TAPS Valdez Marine Terminal

			Frequency Range				Release (Spill) Characteristics				
Event No.	Scenario Description	Estimated Frequency (per year)	Anticipated (>0.5/yr)	Likely (0.03 to 0.5/yr)	Unlikely (10^{-3} to 0.03/yr)	Very Unlikely (10^{-6} to 10^{-6}/yr)	Crude/ Oil Products	Spill Volume (bbl)	Release Duration	Release Point/ Environmental Media	Spill Reaches Water?
1	Small leak of crude oil during VMT[a] operations	~0.5	X				Crude oil	13.0	Short	Land, outside containment	No
								0.5	Short	Water (Port Valdez)	Yes
2	Small leak of diesel fuel during VMT operations	~0.5	X				Diesel fuel	15.0	Short	Land, outside containment	No
								0.02	Short	Water (Port Valdez)	Yes
3	Moderate leak of crude oil during VMT operations	3.0×10^{-2}		X			Crude oil	3,200	Short	Land, outside containment	No
								1,700	Short	Water (Port Valdez)	Yes
4	Moderate leak of diesel fuel during VMT operations	3.0×10^{-2}		X			Diesel fuel	300.0	Short	Land, outside containment	No
								0.7	Short	Water (Port Valdez)	Yes
5	Cargo tank vessel cracks discovered while loading crude oil	4.7×10^{-2}		X			Crude oil	500	Short	Water	Yes
6	Failure of loading system between terminal dock and ship	1.7×10^{-3}			X		Crude oil	80	Instantaneous (10 seconds)	Water	Yes

TABLE 4.4-2 (Cont.)

			Frequency Range				Release (Spill) Characteristics				
Event No.	Scenario Description	Estimated Frequency (per year)	Anticipated (>0.5/yr)	Likely (0.03 to 0.5/yr)	Unlikely (10^{-3} to 0.03/yr)	Very Unlikely (10^{-6} to 10^{-6}/yr)	Crude/ Oil Products	Spill Volume (bbl)	Release Duration	Release Point/ Environmental Media	Spill Reaches Water?
7	Diesel fuel line rupture	1.0×10^{-4}			X		Diesel fuel	450	Short	Land	No
8	Pipeline failure between the east tank farm and the west manifold	1.3×10^{-5}				X	Crude oil	11,300	Short	Land	No
9	Pipeline failure between west metering and Berth 5	1.3×10^{-5}				X	Crude oil	5,900	Short	Land	No
								1,900	Short	Water	Yes
10	Aircraft crash into crude oil tank at East Tank Farm, w/fire	2.1×10^{-5}				X	Crude oil	382,500	Prolonged	Air (dike fire)	No
11	Catastrophic rupture of a crude oil storage tank (e.g., foundation or weld failure)	1.8×10^{-6}				X	Crude oil	50,350	Instantaneous	Land, outside containment	No
								143,450	Instantaneous	Water (Port Valdez)	Yes
12	Catastrophic rupture of a diesel fuel tank	2.2×10^{-6}				X	Diesel fuel	40,000	Short	Land	No

[a] VMT = Valdez Marine Terminal.

Spills that occur very frequently (because of incorrect hose placement, equipment error, etc.) result in liquid releases in less than 1 hour. For example, a valve that is incorrectly turned could cause a leak, but the operator would notice the liquid on the ground and manually close the valve. Such a leak typically occurs in a time frame of less than 1 hour. Short duration releases include the "guillotine" break (complete break in the line) scenarios. A release from events such as an underground corrosion leak could occur over several days before it was noticed. In addition to giving the release duration, Tables 4.4-1 and 4.4-2 provide (1) a brief description of the spill scenario, (2) frequency range, (3) type of material spilled, (4) range in spill volume, (5) release point (above and/or below ground), and (6) release duration. The scenario spill frequencies given are specific to the entire pipeline (i.e., 800 mi) or to specific facilities within the Valdez Marine Terminal.

Although each of these spill scenarios poses an environmental risk, because of the potential volume of released material (upper end of spill ranges are greater than 15,000 bbl), Scenarios 16, 19, 20, and 21 would likely result in the largest environmental consequences. This observation, however, does not necessarily imply that these spills would represent the largest risk events for the TAPS ROW renewal. In this analysis, risk is taken to be the product of the annual frequency of a spill event and its severity consequences. Therefore, if a particular postulated event is calculated to potentially cause large consequences but occurs with low frequency, the calculated risk would be small. The development of the very unlikely catastrophic scenarios and their locations along the pipeline and at the Valdez Marine Terminal are described in Section 4.4.1.3.

4.4.1.1.1 Pipeline Spill Scenarios. Table 4.4-1 shows the 21 pipeline spill scenarios analyzed in this DEIS. The first group of TAPS pipeline events, Scenarios 1 through 8 in Table 4.4-1, was developed from consideration of more than 250 documented pipeline spills (TAPS Owners 2001b) during the first 25 years of pipeline operation. The scenarios include spills of North Slope crude and TAPS-related refined petroleum products (gasoline and diesel and turbine fuels), with a wide range of spill initiators or causes, ranging from equipment failure (e.g., faulty valves or drain plugs, sump pump failure, vent discharge) or human error (e.g., failure to follow maintenance procedures) to acts of vandalism. The spill volumes for these scenarios range from less than 1 to 1,800 bbl, and the durations are assumed to be short. The descriptions and locations of the top 10 spills, with spill volumes greater than 10,000 gal of crude oil, that have occurred along the pipeline from 1977 through November 2001 are shown in Figure 4.4-1. Although the historical record shows that these spills have occurred most frequently at PS 1 and 2 (about 30% of the spills) and along the pipeline segment between PS 4 and 5 (about 10% of the spills), they can generally be considered independent of pipeline location for spill scenario projections during the ROW renewal period. In light of the issues of pipeline aging and implementation of the RCM program for TAPS (APSC 2001k), these anticipated or likely spill projections appear to be reasonable to use in assessing the risk of these relatively small events over the ROW renewal period.

To avoid a double counting of spills associated with specific initiators considered under the likely to unlikely spill events, data for four specific spills reported in the TAPS Spills Database were screened from events composing Scenarios 1 through 8. Data for these spills were used in developing the sabotage/ vandalism (Scenario 12) and ground settlement (Scenario 15) scenarios listed in Table 4.4-1. These events included the February 15, 1978, Steele Creek sabotage event involving an explosive detonation at MP 457 and the more recent October 4, 2001, random vandalism act at MP 400 near Livengood. Two ground settlement-induced crude spills occurred in 1979. The first involved the melting of thick ice lenses in weathered bedrock beneath a section of buried pipe at Atigun Pass, and the other involved pipeline settlement near PS 12 caused by melting of ground ice in silty settlement. The locations of these two spills, along with eight others, are shown in Figure 4.4-1 as the 10 largest pipeline and Valdez Marine Terminal spills during TAPS operations.

Scenarios 9 through 12 and 14 through 16 were developed from data reported in previously identified TAPS-specific spill analyses or risk assessments and historical data compiled by the DOT for other pipeline systems. The seven likely or unlikely events, with spill totals ranging from 50 to 16,000 bbl of crude, included spills resulting from (1) damage from maintenance activity, (2) overpressurization from spike in hydraulic head, (3) flange or seal leaks, (4) vandalism or sabotage, (5) corrosion, (6) settlement or subsidence, and (7) cracks in the pipeline from seismic activity.

The last group of events, Scenarios 13, 17, 18, 20, and 21, summarized in Table 4.4-1, were developed from statistical data for potential spill event initiating activities along the pipeline and data or guidance from the DOT, DOE, and FAA. Crude oil releases from these types of events would generally be considered to lead to a catastrophic spill. These five scenarios were in the very unlikely event frequency category and included (1) tank failure at a pump station, and guillotine breaks from (2) a large truck, (3) helicopter, or (4) fixed-wing aircraft impacts, and (5) seismic-initiated landslides. Pipeline milepost spill volumes for the guillotine break scenarios were estimated with the aid of the APSC Oil Spill Volume (OSV) Model (Carpenter 1997).

4.4.1.1.2 Valdez Marine Terminal Spill Scenarios. Table 4.4-2 shows the 12 Valdez Marine Terminal spill scenarios developed and analyzed in this DEIS. The Valdez Marine Terminal Scenarios 1 through 4 were developed from more than 250 documented spills at the terminal (TAPS Owners 2001b) during the first 25 years of operation of the pipeline. The scenarios covered spills of North Slope crude oil and diesel fuel. The spill volumes for these scenarios ranged from about 15 bbl of diesel fuel to 3,200 bbl of crude oil, all of short spill duration. Spill initiators or causes and spill size ranged from relatively small fuel line ruptures to large valve leaks at storage tanks.

Scenarios 5 through 7 were developed from data reported in previously identified Valdez Marine Terminal specific spill analyses or risk assessments and historical data compiled by DOT for other marine terminals. Scenario 5 is in the likely category, whereas Scenarios 6 and 7 have frequencies in the unlikely category, with spill totals ranging from 80 to 500 bbl of oil. The scenarios are as follows:

- Scenarios 5 and 6 are equipment-related failures occurring during loading operations at berths. Scenario 5 is a crack in the cargo tank of a vessel loading Alaskan crude oil. The majority of the oil is contained inside a boom. Scenario 6 is a leak in loading arm berths 3 through 5, which is assumed to take 10 seconds to discover and close the valves; most of the oil is contained inside a boom.

- Scenario 7 is a diesel fuel line rupture. The line is a 1,800-ft-long 16-in.-diameter pipeline connecting Berth 1 loading arms with the diesel tanks at the Valdez Marine Terminal.

Scenarios 8 and 9 are overpressurization pipeline ruptures caused by inadvertent valve closure. In Scenario 8, the rupture in the pipeline is between the East Tank Farm and the West Manifold, and in Scenario 9, it is between the west metering station and Berth 5.

The last three scenarios, 10 through 12, summarized in Table 4.4-2 were developed from statistical data for potential spill event initiating activities at the Valdez Marine Terminal and data or guidance from DOT, DOE, and the FAA. These types of events would generally be considered to lead to catastrophic spills. A total of three scenarios were developed as very unlikely events, including (1) aircraft crash with subsequent fire followed by a prolonged secondary containment area fire in the east tank farm, (2) a failure of a 510,000-bbl crude oil tank, and (3) a rupture of a diesel fuel tank.

4.4.1.2 Transportation-Related Spill Scenarios

Table 4.4-3 shows the seven proposed action transportation spill scenarios developed and analyzed in this DEIS. The first two events can be categorized as very unlikely truck accidents involving spills of turbine fuel and arctic-grade diesel. The last five have unlikely or very unlikely frequencies and involve truck

Click here to view Figure 4.4-1

FIGURE 4.4-1 Locations and Descriptions of the Largest Historical Pipeline and Valdez Marine Terminal Oil Spills (Source: ADEC 2001b)

TABLE 4.4-3 Summary of Spill Scenarios for Continued Operation of the TAPS: Transportation Accidents

			Frequency Range				Release (Spill) Characteristics				
								Spill Volume (bbl)			
Scenario No.	Spill Scenario Description	Frequency (1/year)	Anticipated (> 0.5/yr)	Likely (0.03 to 0.5/yr)	Unlikely 10^{-3} to 0.03/yr)	Very Unlikely (10^{-6} to 10^{-3}/yr)	Spill Material	Low	High	Release Duration	Release Point
1	Overturn of a liquid turbine fuel truck between the North Pole Refinery to PS 7	3.6 – 6.2 $\times 10^{-5}$				X	Turbine fuel	119	190	Instantaneous	Above ground, on land
2	Overturn of a fuel truck carrying Arctic grade diesel between the North Pole Refinery to PS 12	1.1 – 1.9 $\times 10^{-4}$				X	Arctic grade diesel	119	190	Instantaneous	Above ground, on land
3	Overturn of a liquid turbine fuel truck between the Petro Star Refinery to PS 12	1.4×10^{-3}			X		Turbine fuel	119	190	Instantaneous	Above ground, on land
4	Overturn of a liquid turbine fuel truck between the North Pole Refinery to PS 9	4.9 – 8.6 $\times 10^{-3}$			X		Turbine fuel	119	190	Instantaneous	Above ground, on land
5	Overturn of a liquid turbine fuel truck with subsequent fire between the Petro Star Refinery to PS 12	1.6×10^{-4}				X	Turbine fuel	119	190	instantaneous	Above ground, on land, air
6	Overturn of a liquid turbine fuel truck with subsequent fire between the North Pole Refinery to PS 7	4.2 – 7.3 $\times 10^{-6}$				X	Turbine fuel	119	190	Instantaneous	Above ground, on land, air
7	Overturn of a liquid turbine fuel truck with subsequent fire between the North Pole Refinery to PS 9	5.8×10^{-4} – 1.0×10^{-3}				X	Turbine fuel	119	190	Instantaneous	Above ground, on land, air

accidents with spills of turbine fuel. Scenarios 1 through 4 were based upon data on Alaska hazardous material spills (ADEC 2001b) and from data available on large hazardous materials spills and spill rates per truck mile (USFS and WEFSEC 1998). Scenarios 3 through 7 were based on data in the DOT Hazardous Materials Information System Database (1990–1995) for highway transportation accidents involving fires and explosions (Brown et al. 2000a). All of the scenarios involved spills initially contaminating land surfaces.

The seven *unlikely* and *very unlikely* hazardous material truck accidents can be summarized as follows:

- *Scenario 1:* A fuel truck carrying liquid turbine fuel from the Williams North Pole Refinery to PS 7 leaves the highway and overturns on Old Richardson Highway. Between 5,000 to 8,000 gal of turbine fuel is spilled.
- *Scenario 2:* A fuel truck carrying Arctic grade diesel fuel from the Williams North Pole Refinery to PS 12 leaves the highway and overturns on Richardson Highway. Between 5,000 to 8,000 gal of diesel fuel is spilled.
- *Scenario 3:* A fuel truck carrying liquid turbine fuel from the Petro Star Refinery in Valdez to PS 12 leaves the highway and overturns on either State Highway 4 or State Highway 1. Between 5,000 to 8,000 gal of turbine fuel is spilled.
- *Scenario 4:* A fuel truck carrying liquid turbine fuel from the Williams North Pole Refinery to PS 9 leaves the highway and overturns on State Highway 2. Between 5,000 to 8,000 gal of turbine fuel is spilled.
- *Scenario 5:* A fuel truck carrying liquid turbine fuel from the Petro Star Refinery in Valdez to PS 12 leaves the highway and overturns on either State Highway 4 or State Highway 1. Between 5,000 to 8,000 gal of turbine fuel is spilled. The spilled amount subsequently ignites and burns.
- *Scenario 6:* A fuel truck carrying liquid turbine fuel from the Williams North Pole Refinery to PS 7 leaves the highway and overturns on Old Richardson Highway. Between 5,000 to 8,000 gal of turbine fuel is spilled. The spilled amount subsequently ignites and burns.
- *Scenario 7:* A fuel truck carrying liquid turbine fuel from the Williams North Pole Refinery to PS 9 leaves the highway and overturns on State Highway 2. Between 5,000 to 8,000 gal of turbine fuel is spilled. The spilled amount subsequently ignites and burns.

4.4.1.3 Catastrophic Spills at Environmentally Important Pipeline or Valdez Marine Terminal Locations

The catastrophic events identified in Tables 4.4-1 and 4.4-2 are discussed in further detail below with reference to sensitive or important environmental or human health and safety receptor locations along the pipeline and in the vicinity of the Valdez Marine Terminal.

4.4.1.3.1 Catastrophic Pipeline Events. A total of six to eight aboveground crude oil relief, or “breakout,” tanks with storage capacities ranging from 55,000 to 210,000 bbl, are projected to serve five to seven TAPS pump stations under the proposed action alternative. A scenario involving catastrophic loss for these tanks is considered in Section 1.1.1 of the *TAPS Pipeline Oil Discharge Prevention and Contingency Plan* (CP-35-1) (APSC 2001m). Considerable data exist for aboveground storage tanks. An example (not related to TAPS) of such a failure occurred in 1988 when a catastrophic failure of a brittle tank spilled 750,000 gal of diesel fuel into adjacent storm sewers that emptied into a nearby river. Another large failure occurred in March 2000 when the entire contents of a tank owned by West Coast Aviation (Unalakleet, Alaska) spilled more than 84,000 gal. On the basis of a review of historical records of large tank failures, the *Guidelines for Chemical Process Quantitative Risk Analysis* (Center for Chemical Process Safety 2000) reports a mean catastrophic tank failure rate of

1.0×10^{-6}/tank-year. The conditional probability of secondary containment failure is on the order of 25%. On the basis of this value, the probability of a catastrophic tank failure for all of the TAPS pump station tanks is projected to be 1.1×10^{-5}/tank year (or with a frequency of about 1 occurrence every 100,000 years), which is considered a very unlikely event. It is estimated that 15,000 to 120,000 bbl of oil could spill from tanks at pump stations because of such an event. However, because of secondary containment around the tanks, only about 700 bbl of crude oil is estimated to spill beyond or outside of this containment at PS 3. On the basis of historical working volumes for the other pump station relief tanks (Norton 2002a), all of the oil is predicted to be captured by the secondary containment at these locations along the pipeline.

The pipeline is monitored from the air by helicopter. Knowing the number of miles of aboveground pipe and assuming about 100 helicopter overflights per year, the likelihood of a pipeline crash can be estimated from the statistical parameters (i.e., target area and crash rates per flight) relating to helicopter crashes with pipelines reported in DOE-STD-3014-96 (DOE 1996). (This analysis does not consider helicopter overflights of the TAPS for tourist sight-seeing trips and other non-APSC-related activities.) Because there are 418 mi of aboveground pipe, the crash frequency is conservatively estimated to be 2.9×10^{-5} per year. Thus, occurrence of such a crash during the renewal period of the TAPS would be considered a very unlikely event. As estimated from the OSV model, guillotine break volumes along the pipeline are estimated to range from 1,000 to 54,000 bbl.

The analysis of fixed-wing aircraft impacts is intended to provide a conservative analysis of the risk from an aircraft crash into the pipeline or other system facility. The approach used was based on guidance published in DOE-STD-3014-96 (DOE 1996). Actual and projected takeoff and landing data for 11 airports within 10 mi of the pipeline over a 21-year period from 1995 through 2015 were used in estimating crash frequencies and impact damage to the pipeline. The airports considered in this analysis are listed in Table 4.4-4. The analysis showed that the impact from a small, single-engine or multiengine aircraft weighing 12,500 lb may cause significant damage (e.g., at least a local pipe perforation) to the pipeline. It was assumed that the impact from a medium to large aircraft weighing between 12,500 to 300,000 lb would result in a guillotine break. The frequency of a guillotine break in the pipeline from air plane impact is unlikely, with an estimated frequency of occurrence of around once in 100 to 400 years (8.6×10^{-3}/yr). On the basis of the analysis supporting the DOE Waste Management Programmatic Environmental

TABLE 4.4-4 Airports within 10 Miles of the Pipeline

Airport	City
Chandalar Shelf	Chandalar Shelf
Coldfoot	Coldfoot
Deadhorse	Deadhorse
Fairbanks International	Fairbanks
Galbraith Lake	Galbraith Lake
Gulkana	Gulkana
Porcupine Creek	Porcupine Creek
Prospect Creek	Prospect Creek
Valdez Airport	Valdez
Wainwright Air Force Base	Fairbanks/Fort Wainwright
Wiseman	Wiseman

Impact Statement (Mueller et al. 1996) and Wall (1974), a conditional probability of 30% of a postcrash fire was assumed. This assumption resulted in an aircraft crash with a fire frequency of 2.6×10^{-3}/yr (once in 400 years).

For the “vehicle impact” scenario, the determination that the steel pipeline could be locally penetrated by an 18-wheeler carrying a heavy load (e.g., pipes) was estimated by using the formula from the Ballistic Research Laboratory (DOT 1996). The analysis conservatively assumes that the engine from a large truck would penetrate the pipeline. The frequency of occurrence of the truck penetration was estimated to be 1.7×10^{-4}, which classifies it as a very unlikely event.

The frequency of a seismically induced leak has been estimated by the superposition of leak risks described in Capstone (2001) and Technica (1991). Superposition is justified because the failure mechanisms for these events are independent. The frequency estimate provided by Capstone assumes that an earthquake of sufficient magnitude to cause a crack would have a return period of 500 years. On the basis of expert judgment, this event might result in an occurrence of 2 leaks per 100 mi of pipeline in the affected region. The resulting base leak frequency is 40×10^{-6} leak per mile per year. This base frequency is adjusted for high-risk areas (bridge and fault crossings, aboveground sections, and geologic watch-list areas). By integrating this adjusted frequency over the pipeline path, the total leak frequency is estimated as 1.2×10^{-2} per year. This is consistent with results presented in Capstone (2001, Table 25). Technica (1991) has identified an independent failure mode that may be active in the vicinity of the Denali Fault. That mechanism is pipe cracking caused by impingement of the pipeline against supports following displacement of the pipeline off of the supports during a severe seismic event. The additional frequency calculated for this event is 1.6×10^{-3}. The superposition of this event with the event reported in Capstone yields a total leak frequency of 1.4×10^{-2}. Spill volumes associated with these events are assumed to be between 3,000 and 16,000 bbl, on the basis of values suggested in the Technica assessment. The Capstone assessment does not postulate spill volumes.

Landslides can be triggered by flood, earthquake, and other events. This spill analysis assumes that the initiator is a strong earthquake, as demonstrated by the historical significant seismic activity in Alaska (see discussion in Section 3.4). The frequency of a TAPS landslide-induced leak or spill resulting in a guillotine break was estimated by first recognizing that the most landslide prone soils have experienced landslides in the past. Analyses of soil cores taken at the centerline of the TAPS show that about 0.05% of the soil along the pipeline previously experienced landslide disturbance (Kreig and Reger 1982). Given that the susceptible soils are found only in the mountainous regions, the expectation would be to find all of the 0.05% of this soil occurring in those regions. Since the length of the pipeline through those regions is approximately 227 mi, the percentage of soil in the mountainous regions with past landslide exposure is estimated to be 0.176% (i.e., $0.05 \times 800/227$). Thus, the probability of an historical landslide area existing at any point along the route within the mountainous region is 0.00176. Assuming a 500-year return period[1] for an earthquake of sufficient magnitude to initiate a landslide, the probability of a landslide event triggered by the earthquake is $0.00176/500 = 3.5 \times 10^{-6}$. This probability is applied as the average over each milepost segment through the mountainous regions: the Brooks Range (MP 140–237), Alaska Range (MP 560–610), and Chugach Mountains (MP 720–800). Since the Brooks Range is in a less seismically active area than the other two mountainous regions, this probability estimate is relatively conservative. The overall probability of a landslide-initiated guillotine break over the entire length of the pipeline is 8.0×10^{-4} ($3.5 \times 10^{-6} \times 229$ mi).

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1 It is assumed that an earthquake with a return period of 500 years is sufficient to induce a landslide because (1) it is known that landslides were triggered by the great Alaska earthquake in 1964 and the return period for such a quake has been estimated to be 700 years (Wesson et. al. 1999); (2) it is reasonable to assume that lesser earthquakes may trigger landslides, they certainly have in other areas; and (3) regional warming in Alaska may be increasing the susceptibility of soils to landslide (see Section 3.3).

Catastrophic spill volumes resulting from guillotine breaks have been assessed at or along 41 pipeline points or segments identified for assessing impacts that may pose the largest environmental consequences and/or impact environmentally important or sensitive receptors. The TAPS crosses widely varying terrain, including the broad Arctic Coastal Plain, three major mountain ranges, hilly uplands, hundreds of small streams, and several major rivers. The five river crossing locations identified in Table 4.4-5 were selected because the rivers are either classified as anadromous fish stream or are designated as Wild and Scenic, or both (Sections 3.7 and 3.28). They also represent rivers in three different portions of the TAPS ROW, as described in Section 3.7. Minton Creek was included because it would receive the largest quantity of crude oil in a guillotine break scenario. The identification of land-based areas included consideration of geology and seismicity. Catastrophic spill impacts are assessed in Section 4.4.4.1 for earthquake-prone areas in the Chugach Mountains (identified as MP 795 through 798, MP 727 through 735 in the table) and the southern edge of the Copper River Basin (MP 710 through 722). MP 587 through 590 and 593 through 600 are located in Wild and Scenic areas. Additional land-based locations were included to be representative of areas with different types of terrestrial wildlife habitats that occur along the TAPS, including lowland tundra, upland tundra, and boreal forest. The evaluated locations were also selected to represent locations where there are limited topographic features that would impede spreading of any spilled oil.

The spill volumes were estimated with the OSV model for three crude oil throughput levels: 0.3, 1.1, and 2.1 million bbl/d (see Appendix A, Section A.15). These crude oil spill volumes are specific to scenarios involving a guillotine-break of the TAPS pipeline and were taken from an APSC-supplied OSV model output file that gave the spill volumes at each survey point (over 100,000 points along the pipeline) for a given TAPS throughput (Norton 2001b, 2002b; Brown 2002). Table 4.4-5 provides the estimated spill volumes at various environmentally important areas along the TAPS pipeline as well as the estimated size of potentially oil-contaminated land surface. Because frequency estimates were developed on a per-mile basis for the spills analysis, mile-averaged guillotine break spill volumes were applied for the areas that encompassed one mile in length. The TAPS pipeline contains a large number of emergency shut-off valves that are located within various mile-long segments along the TAPS. In these cases, two guillotine break spill volumes were computed, one before the valve and the other after the valve. The higher of the two estimated spill volumes was conservatively applied for mile-long segments containing valves. For areas with lengths less than one mile, the maximum spill volume for the identified length of pipeline was applied, as a conservative measure, because the method of spill volume averaging by the OSV modeling results could not be readily ascertained.

Large spill events along these pipeline segment locations could have both land-based and/or water-based impacts. The locations (by name and pipeline milepost numbers) of specific water bodies and land-based sites, the predicted maximum computed crude oil spill quantities, and the estimated potentially contaminated areas are given in Table 4.4-5. These estimates conservatively assume that the spill would continue to spread on the basis that containment by spill response would not occur. Although one might expect larger spill volumes with higher pipeline operating throughputs, other factors may result in larger spill volumes at lower throughputs (see Table 4.4-5). These factors would include the location of the pipeline break relative to check or gate valves, the pipeline pressure at that location, and valve closing time.

Two approaches — parametric and objective analyses — were used to arrive at estimates of the area that may be potentially contaminated by a crude oil or other petroleum product spill. Estimates of the extent of ground contamination based on the parametric approach are applicable to spill areas along the pipeline on essentially flat terrain. The objective analysis essentially applies to all other spill areas where terrain features would constrain the spread (e.g., terrain obstacles) of crude oil or influence the direction of that spread (e.g., terrain slope). The estimated spill areas and volumes for the guillotine break scenarios at the three simulated crude oil throughput levels are provided in

TABLE 4.4-5 Milepost-Specific Maximum Guillotine Break Crude Oil Spill Volumes

Geophysical Feature (name/type)	Approixmate Pipeline Location (MP or MP Range)	Guillotine Break Volumes (bbl) by Pipeline Throughput Level			Estimated Maximum Spill Areas (acres) by Pipeline Throughput Level[a]									Objective Analysis
					0.3×10^6 bbl/d			1.2×10^6 bbl/d			2.1×10^6 bbl/d			
		0.3×10^6 bbl/d	1.1×10^6 bbl/d	2.1×10^6 bbl/d	1 in.	2 in.	3 in.	1 in.	2 in.	3 in.	1 in.	2 in.	3 in.	
Water-Based														
Sag River	83–85[b]	28,998	29,880	31,662	NA[c]	NA	NA	NA	NA	NA	NA	NA	NA	NA
Yukon River	353–354	20,477	21,246	17,676	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Tanana River	531	7,489	8,486	11,612	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Gulkana River	654–655	26,308	27,930	24,690	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Tazlina River	686–687	17,334	18,291	15,871	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Minton Creek	510	52,390	53,967	50,561	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Land-Based														
Spectacled eider, lowland tundra	1–12	22,168	23,228	24,552	34	17	11	36	18	12	38	19	13	NA
Upland tundra	86–88	27,077	27,946	29,687	42	21	14	43	22	14	46	23	15	6.1
Cultural resources	112–115	41,274	42,238	43,430	64	32	21	65	33	22	67	34	22	72.7
Upland tundra	129–130	20,931	21,734	22,757	32	16	11	34	17	11	35	18	12	NA
Brooks Range (cultural resources)	142–144	34,030	34,677	35,485	53	26	18	54	27	18	55	27	18	18.2
Brooks Range (cultural resources)	215–216	27,120	29,797	26,647	42	21	14	46	23	15	41	21	14	12.1
Brooks Range (cultural resources)	226–228	32,916	35,425	32,492	51	25	17	55	27	18	50	25	17	3.9
Boreal forest	253–254	19,233	21,379	18,995	30	15	10	33	17	11	29	15	10	12.7
Boreal forest	317–318	41,832	43,098	40,338	65	32	22	67	33	22	62	31	21	18.2
Boreal forest; Yukon Valley	358–360	28,726	29,419	25,639	44	22	15	46	23	15	40	20	13	12.1
Boreal forest	388–390	28,234	28,506	30,394	44	22	15	44	22	15	47	24	16	21.8

TABLE 4.4-5 (Cont.)

Geophysical Feature (name/type)	Approximate Pipeline Location (MP or MP Range)	Guillotine Break Volumes (bbl) by Pipeline Throughput Level			Estimated Maximum Spill Areas (acres) by Pipeline Throughput Level[a]									Objective Analysis
					0.3×10^6 bbl/d			1.2×10^6 bbl/d			2.1×10^6 bbl/d			
		0.3×10^6 bbl/d	1.1×10^6 bbl/d	2.1×10^6 bbl/d	1 in.	2 in.	3 in.	1 in.	2 in.	3 in.	1 in.	2 in.	3 in.	
Cultural resources	396–397[b]	31,722	31,582	32,180	49	25	16	49	24	16	50	25	17	12.1
Boreal forest	410–411	49,211	49,167	46,320	76	38	25	76	38	25	72	36	24	24.2
Land-based	450	40,172	44,544	45,964	62	31	21	69	34	23	71	36	24	0.2
Goldstream Creek	448–453[b]	47,460	52,155	53,565	73	37	24	81	40	27	84	41	28	NA
Air quality (near Fairbanks)	456–458	36,663	40,905	42,101	57	28	19	63	32	21	65	33	22	NA
Air quality (near Fairbanks)	475	12,002	15,047	15,156	22	11	7	29	14	10	30	15	10	NA
Land-based	480	35,506	38,400	38,229	55	27	18	59	30	20	59	30	20	0.2
Boreal forest	482–483	31,377	34,092	33,831	49	24	16	53	26	18	52	26	17	45.0
Boreal forest; Frank Tanana Valley	521–523	26,638	27,892	34,370	41	21	14	43	22	14	53	27	18	NA
Upland tundra, Alaska Range	557–558	17,894	18,752	19,949	28	14	9	29	15	10	31	15	10	48.5
Upland tundra, Alaska Range	565–567	14,043	14,916	16,200	34	17	11	35	17	12	37	18	12	54.5
Seismically active, Alaska Range	587–590	16,301	17,507	15,734	25	13	8	27	14	9	24	12	8	12.1
Seismically active, Alaska Range	593–600	24,830	26,119	26,891	37	19	12	39	20	13	41	20	14	24.2
Boreal forest	619–622	16,906	18,510	19,239	26	13	9	29	14	10	30	15	10	52.1
Boreal forest	632–635	39,348	41,196	42,026	61	30	20	64	32	21	65	33	22	7.3

TABLE 4.4-5 (Cont.)

Geophysical Feature (name/type)	Approximate Pipeline Location (MP or MP Range)	Guillotine Break Volumes (bbl) by Pipeline Throughput Level			Estimated Maximum Spill Areas (acres) by Pipeline Throughput Level[a]									Objective Analysis
		0.3×10^6 bbl/d	1.1×10^6 bbl/d	2.1×10^6 bbl/d	0.3×10^6 bbl/d			1.2×10^6 bbl/d			2.1×10^6 bbl/d			
					1 in.	2 in.	3 in.	1 in.	2 in.	3 in.	1 in.	2 in.	3 in.	
Boreal forest, Copper Plateau	660–680	40,260	41,596	39,614	62	31	21	64	32	21	61	31	20	NA
Land-based	692	13,322	14,198	12,060	21	10	7	22	11	7	19	9	6	5.5
Land-based	695	34,828	35,662	33,470	54	27	18	55	28	18	52	26	17	5.5
Boreal forest, Copper Plateau	700–705	37,624	38,359	36,317	58	29	19	59	30	20	56	28	19	55.8
Seismically active, Copper River Basin	710–718	32,940	33,530	31,691	51	25	17	52	26	17	49	25	16	22.4
Seismically active, Copper River Basin	719–722	26,600	27,054	25,253	–[d]	–	–	–	–	–	–	–	–	–
Seismically active, Chugach Mountains	727–729[b]	25,618	15,524	13,619	40	20	13	24	12	8	21	11	7	24.2
Seismically active, Chugach Mountains	730–735	32,110	20,950	19,010	–	–	–	–	–	–	–	–	–	–
Seismically active, Chugach Mountains	795–798[b]	21,679	35,893	26,258	–	–	–	–	–	–	–	–	–	–

[a] Based on spill volumes for three TAPS daily throughput levels and assumed parametrically adjusted pool depths of 1, 2, and 3 in.

[b] A portion of the pipe between the two mileposts indicated would be below ground. The spill areas indicated would not be applicable to those pipeline segments.

[c] NA = the objective analysis is not applicable for this particular pipeline location (see text discussion).

[d] A dash indicates a belowground pipeline segment, guillotine break from landslide is possible. See discussion of possible surface contamination in Section 4.4.4.1.

Table 4.4-5 for the identified environmentally important milepost locations. Spill areas and volumes for locations along the pipeline that are given over MP ranges (e.g., MP 86–88) are the computed maximum values of milepost-to-milepost calculations.

Spill areas estimated with the parametric approach were simply calculated by dividing the projected spill volume by a parametric adjustment to an assumed crude oil spill depth. At the time when the crude oil stops spreading, the spilled liquid pool on the ground was assumed to have an average depth or thickness of 1, 2, or 3 in. To assure conservative estimates of spill areas, it was assumed that no crude oil losses occur from seepage into the underlying surface or from evaporation to the atmosphere. Evaporation alone could result in a loss in pool mass by as much as 15% within 24 hours. This would result in a proportional reduction in the estimated contaminated areas, as determined by the parametric-derived values listed in Table 4.4-5. Since spill volume was not explicitly factored into the area estimates determined with the objective analysis, neglecting evaporation would have a nonproportional influence on those values (see further discussion below). Finally, the parametric method inherently maximizes the extent of the estimated contamination or spill area by conservatively neglecting surface roughness, viscous drag on the crude oil from contact with the surface, and liquid surface tension. All spill surfaces were conservatively assumed to be nonporous. In addition to the estimated areas for guillotine spills on flat terrain, as required, the spill areas were also estimated using the parametric approach for all of the other scenarios involving smaller spill volumes (see Section 4.4.4).

The use of the objective analysis method for estimating the size of a contaminated area on land is restricted to terrain constraining spill spread areas where significant terrain features can be clearly discerned from topographic maps, and for which spill volumes were large enough to sufficiently cover the area constrained by the topographic and/or hydrologic feature. This essentially restricted the application of the objective analysis to the guillotine break spill scenarios. The objective analysis takes advantage of site-specific land features, such as slopes, surface water bodies, access roads, workpads, and/or highways, that control the pathway of a plume and influence the extent of ground contamination from a surface release of liquid such as crude oil.

The objective analysis is based on three main assumptions. First, the land features at a release site are the sole controlling factors in determining the size of a contaminated area. Factors that would reduce the size of a contaminated area, such as evaporation and infiltration, are not included. Further, as stated above, the volume of oil released is assumed to be sufficient to cover the estimated area. The analysis assumes that the land features provide constraints that maximize the estimated area. If the volume of oil from a guillotine break is relatively small, say less than about 20,000 bbl, and the terrain of a spill site is flat or slopes gently, a plume might stop spreading before it reaches an interceptor. In this case, the method fails and the areas estimated with the parametric approach would be better used in assessing the environmental consequences.

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2 It is estimated that 13% by weight of a North Slope crude oil spill would evaporate to the atmosphere within 24 hours. This loss would primarily be in the light-end components and at ambient temperatures of around 15°C. This loss over the same 24-hour period is estimated to increase by around 2 to 3%, with a 10-degree rise in temperature. As the more volatile crude oil components evaporate, the rate of loss from the surface declines. These estimates are based on empirically derived expressions by Fingas (1996) who notes that for periods less than 5 to 10 days after a spill, evaporative losses seem to follow a power law square root function with time, and then a logarithmic function for the longer elapsed times. Therefore, for periods greater than 5 to 10 days after a spill it is estimated that around 18% of the oil would evaporate in one week, with only an additional 5% loss at the end of 8 weeks. These estimates assume a mean temperature of around 15°C. The equations specific to North Slope crude were used in calculating the evaporative losses reported above. These estimates are based on statistically derived empirical expressions by Fingas (1996), who measured and studied the evaporative characteristics of approximately 20 different crude oils, including North Slope crude, and several petroleum products (e.g., diesel fuel). Experimental and distillation data were reviewed, and "best-fit" equations were determined for estimating the rate of evaporation with temperature and time.

Second, the objective analysis assumes that throughput-dependent milepost spill volumes can be ignored for large spills and reasonably close spread-constraining land features. This assumption is valid because the volume of a spill in a guillotine break is generally very large and the spill duration is very short (i.e., the release from the pipeline would be complete in less than 6 hours). With a few notable exceptions, many land features can control the spread of oil. However, in certain cases the estimated contaminated areas may be greatly over-estimated by not explicitly accounting for the milepost-dependent spill volumes.

Third, as crude oil is released from a guillotine break site, it follows the slope of the land surface and is guided by workpads, access roads, or roadbeds of highways to lowlands, ravines, creeks, streams, ponds, or lakes (or interceptors). Therefore, the land features would limit the size of a spill site that can be effectively estimated by multiplying the length of the plume by its width. On a site with a steep slope, the width of a plume is arbitrarily assumed to be 50 ft, whereas a site with a gentle slope has an assumed width of 100 ft.

Finally, the estimated areas computed with either the parametric method or with the objective analysis conservatively assume that the spill duration and/or spread time is much smaller than the time required for spill response and control. In other words, no spill mitigation is assumed for land spills.

In addition to the guillotine breaks at environmentally sensitive or important milepost-specific receptors, a range of spill volumes was estimated for small and moderate leaks, maintenance damage, sabotage or vandalism, washout, and valve leaks (Table 4.4-1). Spill areas for the small to moderate spills were estimated by multiplying the spill volume in barrels. by 0.001547 (units conversion factor, bbl to in.^{3}) for a 1 in. pool and dividing the result by 2 or by 3 for a 2-in. or 3-in.-deep pool. The estimated spill areas that maximize impacts at each environmentally important location along the pipeline were used in the consequence assessments. Impacts for the other estimated spill areas, either from the parametric approach or the objective analysis, were treated qualitatively.

4.4.1.3.2 Catastrophic Valdez Marine Terminal Events. The potential exists for a large release of soot and gaseous air contaminants as a result of an aircraft crash into the crude oil storage tanks at the Valdez Marine Terminal. The 18 crude oil storage tanks at Valdez Marine Terminal are located in two areas, the East and West Tank Farms, with individual tank storage capacities exceeding 0.5 million bbl. In this analysis, an aircraft accident was defined to be an event that results in destruction of the aircraft by the impact and subsequent fire. A methodology was used that takes into consideration items determined to be important to understanding the risk from an aircraft crash into fixed facilities (DOE 1996). These items include number of aircraft operations/flights, crash probabilities, aircraft characteristics, crash kinematics, impacting missiles, and structure characteristics. The current and projected future numbers of aircraft operations from the Valdez Airport were used in conjunction with national crash statistics to estimate the annual frequency of an aircraft crash into the crude oil tanks at the Valdez Marine Terminal. Structure characteristics (wall thickness, material properties), together with consideration of the various detached parts of an aircraft (e.g., engine) that can hit a target directly from the air or after skidding on the ground, were used to estimate the degree of local damage and whether the aircraft or aircraft part would penetrate the tank wall and cause tank failure.

Catastrophic storage tank failure or rupture is extremely rare. Eight cases of crude oil tank rupture are known from around the world — three caused by foundation failure, one caused by weld failure, one caused by impact of a rail truck, and three caused by flooding. Flooding is the only one of these initiators relevant to the Valdez Marine Terminal. The chance of this happening is extremely remote since there is no large source of runoff water at the storage areas, and secondary containment drainage is good and well controlled. For the present purpose, however, the possibility is considered. If a tank were to rupture, the most likely consequence would be a major flow of oil to the secondary containment. In the case of a very large rupture (greater than about 5 ft in diameter), it is likely that the oil would wash over or break the dike wall. In this case, oil would disperse over the hillside below the tank farm and flow to surface drainage. The volume of spilled oil would almost certainly be greater than the capacity of diversion impounding, except the final dam at the outflow of No Name and Dayville Creeks (Emerald 2001). The frequency of a storage tank failure spill event at the Valdez Marine Terminal is estimated to be 1.8×10^{-6}. Such tank failures were determined to be very unlikely events that could produce spill magnitudes ranging from approximately a 50,000-bbl spill on land outside secondary containment, to a spill of more than 143,000 bbl of crude oil into the Port of Valdez.

A 1989 American Petroleum Institute (API) survey indicated that there were approximately 700,000 aboveground diesel fuel storage tanks in the United States. Tank rupture accounted for only 5.4% of the 132 releases that occurred worldwide between 1970 and 1988. However, tank rupture accounted for almost 19% of the released material. This analysis considers a spill scenario involving a catastrophic rupture of tanks containing diesel fuel at the Valdez Marine Terminal. The frequency of such an event is estimated to be 1.1×10^{-6} per tank-year (Center for Chemical Process Safety 2000). Two tanks, each with a shell storage capacity of 40,000 bbl, store diesel fuel at the Valdez Marine Terminal.

4.4.2 Hydrological Analysis of Spill Events

Because the density of the crude oil transported through the TAPS is less than the density of water (about 0.8699 g/cm^3 for oil [APSC 2001o] and 1.0 g/cm^3 for water), oil spilled into water will tend to float on the surface and spread. If the water is moving, the oil will be transported downstream by the surface currents (advection). The combined motions of spreading and advection will produce an elongated oil slick. The slick will, in general, move downstream at the speed of the surface current; however, winds may alter the direction of transport. Wind-induced surface currents have been reported to vary between 1 and 6% of the wind speed, with 3% being the most widely used drift factor in oil slick trajectory models (Shen and Yapa 1988). Depending on the direction of the wind, the slick can be driven to one of river's banks, where it then can be recovered.

Oil Slick

A slick refers to oil spilled on the water that absorbs energy and dampens out surface waves, thus making the oil appear smoother, or slicker, than the surrounding water (NOAA 2001).

Some light hydrocarbons in the crude oil may dissolve or evaporate. In turbulent water, some of the oil may be emulsified as small dispersed droplets (oil-in-water emulsions). It is now believed that the nonhydrocarbon fraction of oil is an important ingredient in emulsification. Under certain chemical and turbulent energy conditions, the emulsified oil can form a substance often referred to as "mousse." This "mousse" is a very viscous fluid that has significantly different physical properties than those of the parent oil (Overstreet and Galt 1995). These emulsified droplets may become dispersed because of the currents present, or they may become attached to suspended matter in the stream and slowly settle to the bottom. If formed, the oil-in-water emulsions can be long lived. The turbulence action can also cause water to become entrained in the oil, forming water-in-oil emulsions, which may weather further and form dense tar balls (Shen and Yapa 1988).

During an oil spill to water, an oil sheen is likely to develop. An oil sheen is a very thin layer of oil that floats on the water surface and is transported downstream with the current (NOAA 2001). The color of the sheen corresponds with its thickness. Silver sheens have a thickness greater than 0.0001 mm, iridescent sheens have a thickness that is greater than 0.0003 mm, brown to black crude oil sheens have a thickness that is greater than 0.1 mm, and brown/orange water-in-oil emulsions are thicker than 1 mm (ITOPF 2002).

While moving as a slick, crude oil can be affected by a number of physical processes. These include advection (moving along with the current); mechanical spreading because of the balance among gravitational, viscous (viscosity is a measure of a fluid's internal resistance to flow), and surface-tension forces; horizontal turbulent diffusion (spreading driven by a difference in concentration); evaporation; dissolution; and shoreline deposition (Shen and Yapa 1988). In addition, photochemical reactions and microbial biodegradation are also possible. The effect of these processes depends on the properties of the oil and environmental conditions. Spreading, dissolution, evaporation, and photochemical reactions of the crude oil usually occur within hours after the spill. Light crude oils can lose as much as 75% of their original volume within the first few days after a spill; medium weight crudes might lose as much as 40% of their original volume. Heavy crude or residual oils, on the other hand, might only lose about 10% of their volume in the same period of time (Overstreet and Galt 1995). The formation of oil-in-water emulsions and sinking can require days. On the other hand, water-in-oil emulsions can require years to degrade.

Water near the center of a stream flows faster than water near its banks or bottom (Fischer et al. 1979). This difference in current speed and the resulting shearing forces between water layers is typically the major mixing mechanism that spreads oil as it moves downstream. The leading edge of the slick may move as a relatively sharp front; however, mixing will continuously exchange water and oil between the slower, near-bank regions and the faster-flowing, central regions of the river. Many river channel profiles (morphologies) are very irregular, with rapids at one extreme and quiet bays at the other. These features either accelerate or decelerate the average flow in the river and contribute to the shear in the current pattern, thus increasing the along-channel spreading of the oil (ESSO 2001).

Sometime after the spill event, oil will reach a shoreline and be deposited. In sands and gravels, the lighter-weight crude oil components may then penetrate the surface, contaminating deeper layers of soil and possibly the underlying groundwater. Some of this deposited oil will be reentrained by the water and transported farther downstream. Exposed headlands (high steep-faced promontories that extend into the water) rapidly lose deposited oil to the adjacent water (Shen and Yapa 1988). One-half of the original mass of oil deposited on a headland is lost back to the stream within one hour. At a sandy beach, it takes about 1 day to lose one-half of the original mass of oil. Sand and cobble beaches, sheltered rock shores, and sheltered marshes can take up to 1 year to lose half of the original mass of oil deposited. Such areas provide potential sources of oil for increases in the length of the original slick and long-term sources of future contamination.

Impacts of oil spills on rivers and streams can be severe. On August 1, 2000, in British Columbia an aging pipeline spilled about 10,700 bbl (449,400 gal) of crude oil into the Pine River (Reuters World Environment News 2000a,b). The 500-mi pipeline, which was built in 1962, carries crude oil from Taylor, British Columbia, to the Prince George Husky Oil refinery. The spill affected fish, wildlife, and riverside vegetation, and compromised the town of Chetwynd's drinking water supply. A sheen more than 13 mi long was observed. Oil is expected to continue to be released from soil and gravel and the riverbed itself for years to come, causing potential contamination problems.

As discussed above, the transport of oil downstream following a spill is a very complex process and can be difficult to analyze. Computer models have been developed to estimate the behavior of oil slicks in rivers (Shen and Yapa, 1988; Yapa and Shen 1994; Overstreet and Galt 1995; Zhubrin 2001). However, these models, in general, require large quantities of field data unavailable for this project. Because such detailed information is not available, simplifying assumptions are made to evaluate the trajectory of the oil slicks and its geometry following a spill at an elevated bridge crossing (Appendix A, Section A.15.2).

4.4.3 Fire Analysis of Spill Events

Pool fires, flash or jet fires, and vapor cloud explosions are three possible types of energetic events involving crude oil and other flammable liquids associated with operation of a petroleum pipeline. Consideration of energetic events, such as a boiling liquid expanding vapor explosion, were excluded from analysis primarily because such events require the existence of pressurized storage vessels containing a saturated liquid/

vapor at temperatures well above its normal boiling point (at atmospheric pressure). Each of the tanks in the East and West Tank Farms have emergency venting (6 to 12 ventilation vent vapor breaks) and weak roof-to-shell seams that would prevent tank pressure buildup.

If the ignition of flammable vapors is delayed, an unconfined vapor cloud explosion or a flash fire could result. Crude oil movement in pipelines requires a pressurized flow. The friction in the flow along the pipe walls elevates the crude oil temperature and any resulting leak would atomize and off gas the basic gas distillates of the carbon chain. If an ignition source was present, a flash fire to the source of the leak could occur and a jet fire would ensue. The recent vandalism act on the pipeline on October 4, 2001, involving a bullet rupture and a pressurized leak in the pipe at MP 400 near Livengood did not result in a fire. Response to events like this is very carefully planned, and special care is taken by the response team to prevent the introduction of an ignition source during the response in repairing the leak. Review of a long record of data from the Office of Pipeline Safety (DOT 2002c) shows no occurrence of explosions, fireballs, or jet/flash fires at crude oil pipelines or pump stations. Although the explosion and fire that occurred at PS 8 during start-up in July 1977 was associated with a spill, the installation of Freon fire suppression systems at all of the pump and metering stations, along with the continued RCM on these systems, has essentially eliminated the likelihood or greatly reduced the recurrence of such an event.

For a vandalism event, such as the Livengood incident, the ignition source required for a pipeline flash/jet fire is dependent on inadvertent introduction by the spill response team. Considering that there have not been any fire events associated with pipeline vandalism recorded in the data available from the Office of Pipeline Safety (DOT 2001c) and because of the special care taken by the APSC response team in responding to such events, a pipeline flash/jet fire was deemed to be an incredible event. However, analysis of the frequency of aircraft take-off and landings from the Valdez Airport and the Fairbanks International Airport show that an aircraft impact into the pipeline near Fairbanks or into a crude oil holding tank at the Valdez Marine Terminal could occur with frequencies of about once in 400 years and once in about 50,000 years, respectively (see Section 4.4.1 and Folga et al. 2002).

The spills analysis identified six spill scenarios involving fires that could be defined as credible events (frequency of occurrence greater than once in a million years). The first two crude oil fire events considered are those occurring at fixed pipeline facilities. Each of these events involves very large crude oil pool fires from an aircraft impact: one in the secondary containment dike at the Valdez Marine Terminal East Tank Farm (identified as Scenario 10 in Section 4.4.1), and one resulting from a pipeline guillotine break near Fairbanks (identified as Scenario 19b, Section 4.4.1). The last four fire spill scenarios are vehicle transportation accidents. Three of the scenarios involve rollovers of fuel tanker trucks carrying liquid turbine fuel during shipments between (1) Williams North Pole Refinery to PS 7, 3, (2) Williams North Pole Refinery to PS 9, and (3) Petro Star Refinery in Valdez to PS 12. The sixth transportation spill scenario involving a fire is a fuel truck shipment carrying arctic grade diesel from the Williams North Pole Refinery to Deadhorse. Because the transportation spill scenarios involved much smaller spill quantities compared with the Valdez Marine Terminal and pipeline fire scenarios, quantitative analysis of these events was not performed. The associated consequences and risk of truck accidents involving flammable and/or explosive materials can be found in the DOT National Transportation Risk Assessment (Brown et. al. 2000a).

To estimate fire impacts, simulations were performed with two models: the Fire Dynamics Simulator (FDS) and FIREPLUME (see fire model descriptions in Appendix A, Section A.15.3). The near-field (distances less than 1 km from the dike fire) air quality impacts from this dike fire were assessed with the FDS model for locations near the dike and pipeline, and at distances from the fire where workers or nearby residences may be exposed. FIREPLUME was used to estimate soot and other combustion product impacts from a few kilometers to 50 km downwind of the dike fire. Considering the uncertainty in any model’s predictions, a decision was made to err on the conservative side by using the results from the model producing the largest concentration estimates in the downwind range from 3 to 10 km.

The specific assumptions made in analyzing fire impacts for the Valdez Marine Terminal and pipeline fire scenarios are described below, along with a summary of the fire modeling results. The associated human health impacts from exposures to fire combustion products (e.g., soot) are discussed in Section 4.4.4.7.2.

4.4.3.1 Valdez Marine Terminal Fire Event (Valdez Marine Terminal Scenario 10)

Scenario 10 assumes that crude oil holding tank #2 in the East Tank Farm, as shown in Figure 4.4-2, catastrophically fails as a result of a direct impact from an aircraft taking off from the Valdez Airport approximately 8.9 km from the Valdez Marine Terminal. The impact from the crash and the resulting fire was assumed to occur in the largest containment area and to be confined to this area. A large crude oil pool fire ignites in the diked area serving two 510,000-bbl storage tanks. Approximately 400,000 bbl of crude spills into the dike from the ruptured tank to a depth of around 2 m and engulfs the entire secondary containment area (~ 34,590 m^2) in fire. It is assumed that the contents of the second tank and the dike walls would not be affected by the spill-fire initiator. The tanks are 250 ft in diameter and 63 ft high. The footprint of each tank covers about 12% of the diked area. The tanks have conical fixed roofs and are connected to a vapor recovery system. Wall thickness is 1 1/8 in. at the bottom, increasing to 1-1/2 in. at the top.

On the basis of a spill of 382,500 bbl of crude oil, the average working level for holding tank #2 (Norton 2002c) into the diked area would cover an almost 9-acre area (adjusted for the area displaced by one of the remaining tanks in the two-tank-per-dike configuration at the East and West Tank Farms). Using this volume and the laboratory-reported North Slope crude oil density of 0.8699 g/mL (APSC 2001o), the total mass of the crude oil spill was calculated to be 5.3×10^7 kg. Using a burn density of 0.051 kg/m^2-s and a dike area of 34,500 m^2, the fire burn rate is calculated at 105,844 kg/min. Therefore, an unmitigated dike fire is estimated to burn for over 8 hours. The total heat release rate (HRR) generated from this fire would be about 74.1 GW (HRR = mass spilled (5.3×10^7 kg) $\times$ heat of combustion (42,000 kJ/kg)/burn time (29,880 s or 8.3 h). By comparison, the heat release rate for largest crude oil controlled burn in the 1994 Mobile experimental Burn Series (Walton et. al. 1993) is about 2 orders of magnitude smaller (estimated to be around 600 MW for a trial involving a spill of 107 bbl over a 231-m^2 area). Because of the high temperatures and velocities that accompany large fires in the gigawatt range, a very buoyant fire plume would be generated. Such a plume would easily penetrate low to moderate level inversions that would trap smoke above these layers.

Considering the very buoyant smoke plume generated from the large dike fire and the important role weather conditions play in transporting and dispersing this plume, careful consideration was made in selecting the meteorological conditions that would be expected to produce the largest ground-level concentrations of soot and other combustion products. For most cases, the buoyancy of the fire plume would be sufficient to penetrate the inversion layers typical to a coastal location like Valdez. A nighttime fire, during stable light wind conditions, would tend to keep the fire plume elevated for a long time, thereby producing a fanning plume shape with little vertical mixing that would result in near zero or extremely small ground-level soot and other combustion product concentrations. However, during such conditions impacts on visual range at long distances would occur on the order of over 30 to 50 km downwind, especially for the smaller size soot fraction. Strong to very strong winds, near or exceeding the vertical velocities of the hot very buoyant fire plume, would be needed to bend the plume over enough to minimize penetration of the inversion layer. A review of meteorological data processed (using EPA's RAMMET meteorological preprocessing program) from 6 years of surface measurements at the NWS station in Valdez and the same period of upper

Click here to view Figure 4.4-2

FIGURE 4.4-2 East Tank Farm Facilities Potentially Affected in the Valdez Marine Terminal Fire Scenario

air observations from the NWS soundings at Anchorage show average mixing heights of 600 m during very unstable conditions (Pasquill-Gifford [PG] stability Class A) and average mixing heights of around 850 m during moderate to slightly unstable conditions (PG Class B and C). During neutral conditions (PG Class D), the average mixing heights are around 560 m. For the same period, the maximum boundary layer heights over consecutive hours during very unstable conditions and moderate to slightly unstable conditions are 500 and 3,000 m, respectively.

Taking these considerations into account, two meteorological conditions were modeled. For the far-field estimates using FIREPLUME, neutral atmospheric conditions with strong winds (10 to 12 m/s) were assumed for the first case (PG Class D) and conditions between a slightly unstable atmosphere and a neutral atmosphere (PG Class C/D). Near-field impacts with FDS were modeled assuming neutral atmospheric conditions (Class D, temperature lapse rate between -1.5 and -0.5°C/100 m) with moderate to strong wind speeds ranging from 12 m/s (~25 mph) from the south towards the Port of Valdez. The wind flow would be across the largest diked area dimension with thermal radiation greatest on the north end (nearest to the tank that is assumed to remain intact). The closest "safe" access by firefighters would be on the road just east of the dike (the dike dimensions are widest at the north end). Fire temperatures, thermal radiation hazard, and fire plume buoyancy parameters were estimated with the FDS model and used as fire buoyancy parameters for the far-field FIREPLUME simulations. The buoyancy parameters were computed over the dike at the pool fire flame height. This height was estimated using a simple empirical correlation for fuels burning as pool fires (NFPA 1997). The flame height was estimated to be 100 m. The FIREPLUME model predictions for the neutral condition case with 10 m/s wind speeds showed that the smoke and soot generated from the fire would be lifted high in the atmosphere and transported far downwind. The maximum predicted ground-level concentrations occurred over 50 km from the terminal. For the slightly unstable to neutral condition case with 7.5 m/s winds and a mixing height of 750 m (Case 1), the smoke and soot were not lifted as high and were brought to the ground closer to the fire than the neutral stability case with a 1,500-m mixing height (Case 2). The predicted FIREPLUME maximum soot and other combustion product concentrations and distances downwind from the Valdez Marine Terminal for these two cases are given in Table 4.4-6. The health impacts to the general public exposed to these concentration levels are discussed in Section 4.4.4.7.2. The averaging time for the estimated concentrations is based on the dike fire burn time. Assuming that the crude oil burn rate would be around 0.051 kg/m^2-s (38 lb/h-ft^2), consistent with the literature on crude oil fires and available field measurements, and assuming a confined dike fire with just the one tank involved, the fire would be estimated to burn for about 8 hours before self-extinguishing.

As noted, the FDS model was used to obtain estimates of the near-field (e.g., within a 3-km radius of the dike fire) soot and combustion product concentrations. The FDS is able to account for fire-induced winds that can influence ground-level concentrations close to the fire. The results from these calculations should be viewed with caution since the model has not been applied to very large fires (>1 GW) and has not been compared with field measurements close to fire (<1 km). The largest fire that the FDS has been applied to is in the Mobile mesoscale experiments conducted in 1991 (Fingas et al. 1996; McGrattan et al. 1995). The lowest of these burns was estimated to be between 600 and 700 MW. With these caveats, several FDS runs were performed with varying computational grid sizes. The results indicated that a grid spacing of 4.5 m was required to adequately resolve the fire physics. Memory constraints limited the number of grid points that could be modeled to approximately one million. Therefore, the largest computational domain possible (750 m in the downwind direction, 240 m in the cross-wind direction, and 500 m vertically) was selected while meeting these constraints. The number of grid points in the X, Y, and Z directions was 162, 54, and 108, respectively. Meteorological conditions were selected that would likely give the maximum downwind ground-level concentration of pollutants emitted from the fire. This would occur, assuming a neutral atmospheric lapse

TABLE 4.4-6 Maximum Public Exposure to Soot and Fire Combustion Products

		Combustion Product (8-hour averages)						
Case[a]	Downwind Distance (km)	TSP (mg/m^3)	PM_{10} (mg/m^3)	CO (mg/m^3)	NO_x (mg/m^3)	SO_2 (mg/m^3)	VOC (mg/m^3)	PAH (mg/m^3)
1	30.5	0.573	0.524	0.115	0.0039	0.096	0.0191	3.82×10^{-4}
2	50	0.29	0.26	0.06	1.9×10^{-3}	0.048	9.5×10^{-3}	1.9×10^{-4}

[a] Case 1: Unstable atmospheric conditions with 7.5 m/s wind speeds and mixing layer heights of 750 m.

Case 2: Neutral to slightly unstable atmospheric conditions with 10.0 m/s wind speeds and mixing layer heights of 1,500 m.

rate of -0.0097°C/m, with moderately strong winds of around 12 m/s.

The fire plume buoyancy parameters were calculated by time- and space-averaging conditions in a horizontal rectangular area 100 m above the fire. The height of 100 m was selected because significant heat was released per unit volume up to this level and thus could be used as the reference height for the FIREPLUME simulations of an elevated buoyant release. The rectangular area had the same dimensions as the secondary containment area (thus the fire), but was shifted 100 m downwind, which was the approximate distance (as measured by passive tracer particles) that the plume was advected as it rose to a height of 100 m. The FDS-computed average temperature, density, and vertical wind velocity above the fire were 411°C, 1.087 kg/m^3, and 14.42 m/s, respectively. The temperature around the surface of oil storage tank #1 was modeled using FDS. Once conditions stabilized, surface temperatures were found to range from 230 to 420°C. If tank #1 was assumed to fail due to thermal fatigue from the fire, its contents would be added to the oil already present in the secondary containment area. Assuming that tank #1 has an equivalent working level as tank #2, this would double the depth of the oil pool. This thermal tank failure would be expected to double the fire burn time and the combustion product burden to the atmosphere. A “boilover” event is also possible (see discussion below). However, it is assumed that fire fighting efforts would be directed to saving tank #1 (the crude oil tank not directly involved in the fire) and averting a tank fire and boilover event.

The near-field workers concentration exposure levels within the marine terminal boundaries, along with distances from the dike fire, are summarized in Table 4.4-7. These 15-minute average values were estimated with the FDS model. Possible worker-related health impacts from exposures to these concentration levels are discussed in Section 4.4.4.7.2.

The hottest pool temperature at a height around 100 m above the surface is predicted to reach about 430°C. Using an estimated flame temperature of 800°F, the thermal radiation intensity to a person outside the flame envelope was estimated with a simple “solid flame radiation” model (Mudan 1984). The thermal radiation hazard to fire fighters and nearby workers at the terminal is summarized in Table 4.4-8. Exposures at the 5-kW/m^2 thermal radiation level for less than 13 seconds are suggested as acceptable (40 CFR 193, 1980). Unprotected (e.g., exposed skin, no personal protective equipment [PPE]) exposures for greater than 40 s at this level can lead to second degree burns, while the same duration of exposure at the 10-KW/m^2 level can lead to 1% fatalities in the exposed population (Mudan 1984).

TABLE 4.4-7 Maximum Worker Exposures to Soot and Fire Combustion Products, Valdez Marine Terminal Scenario 10

		Combustion Product (15-min averages)						
Location	Distance (m)	PM_{10} (mg/m^3)	CO (mg/m^3)	NO_x (mg/m^3)	SO_2 (mg/m^3)	VOC (mg/m^3)	PAH (mg/m^3)	CO_2 (mg/m^3)
Containment edge south	190	4.18	0.92	3.05×10^{-2}	7.63×10^{-1}	1.53×10^{-1}	3.05×10^{-3}	48.6
Containment edge north	196	4.18	0.93	3.05×10^{-2}	7.63×10^{-1}	1.53×10^{-1}	3.05×10^{-3}	48.6
E Manifold Receiving Building	340	1.46	0.32	1.07×10^{-2}	2.66×10^{-1}	5.33×10^{-2}	1.07×10^{-3}	17.0
Sludge pit	372	1.10	0.24	8.03×10^{-3}	2.01×10^{-1}	4.01×10^{-2}	8.03×10^{-4}	12.8
Offices	730	0.685	0.15	5.00×10^{-3}	1.25×10^{-1}	2.50×10^{-2}	5.00×10^{-4}	7.96
Ballast Water Treatment Facility	794	0.643	0.14	4.69×10^{-3}	1.17×10^{-1}	2.35×10^{-2}	4.69×10^{-4}	7.48
Maintenance/ warehouse	808	0.595	0.13	4.34×10^{-3}	1.09×10^{-1}	2.17×10^{-2}	4.34×10^{-4}	6.92
Emergency response/ laboratory building	973	0.462	0.10	3.37×10^{-3}	8.43×10^{-2}	1.69×10^{-2}	3.37×10^{-4}	5.37
Marine building	1,091	0.403	0.088	2.94×10^{-3}	7.35×10^{-2}	1.47×10^{-2}	2.94×10^{-4}	4.69

TABLE 4.4-8 Thermal Radiation Exposures, Valdez Marine Terminal Scenario 10

Location	Distance from fire (m)	Estimated Thermal Radiation Hazard (kW/m^2)
OCC Building	1,125	0.593
Sludge processing area “sludge pit”	250	6.27
East Manifold Building	180	13.5
Road around perimeter of dike	Very close to fire	37.5 to 75

This scenario assumes a dike fire with a relatively shallow crude oil depth of around 6 ft (i.e., estimated assuming a spill of 382,500 bbl of crude oil over an area of ~34,600 m^2 [~372,000 ft^2]). "Shallow-layer" boiling effects from the liquid water present at the bottom of the dike would be of a relative small magnitude compared with that of "deep layer" "boilovers"[3] that can and have occurred in large crude oil tanks (e.g., oil refinery, Milford Haven, South Wales, England, August 1983; oil terminal, Thessalonika, Greece, February 24, 1986). The magnitude of a boilover event is defined as the ratio of the maximum burning rate of crude when boiling occurs to the burning rate of the liquid at its steady state condition (Koscki and Mulholland 1991). Tank boilover events that have occurred have crude oil depths several times larger than what would be possible for dikes. The depth of crude oil is important relative to what would be necessary to generate a sufficient heat wave cycle. However, less violent effects can occur in dike fires, such as "slopover" or "frothing." "Frothover" is steady frothing of liquid over a tank rim or dike wall without a sudden or explosive event typical with boilover. "Slopover" is a short-duration froth over containment with usually minor intensity and small containment loss of liquid compared with a frothover or boilover event. "Slopover" or "frothing" can be easily contained with foam application and would therefore not be expected to spread the fire to the crude oil tanks in adjacent secondary containment areas at the East Tank Farm.

The dike fire scenario assumes that the fire protection measures already in place and existing firefighting response capabilities would prevent a crude oil tank fire and deep-layer "boilover" event. This assumption implies the availability of a high-level of industrial fire fighting capability from a well-trained and equipped Valdez Marine Terminal fire brigade with support, as necessary, from the Valdez Fire Department. Because of the uncertainties inherent in this assumption, several important factors need to be considered in evaluating what it would take to successfully contain dike fires and prevent escalation to adjacent terminal facilities.

First, it is likely that the vapor recovery system serving the tanks in the affected and adjacent dikes would fail either at the point of the initial aircraft impact into the affected tank or at some point during the subsequent dike fire. Without that system operating, flammable vapor would build up and be emitted from the roof vents as the tank was heated from the outside. North Slope crude has a flashpoint of -11.1°C (12°F) [APSC 2002c]. Under the intensely hot flames emanating from the dike fire, with temperatures in excess of 600°C (1,112°F) and with flame heights ranging from 50 to 100 m, ignition of the tank vent vapors would be highly likely. Because each of the fixed-roof pressure relief vents serving the tanks in the East and West Tank Farms are equipped with flame arresters, subsequent ignition of the vapor space inside any of the tanks is not an immediate concern. As previously mentioned, the relief vents are primarily designed to prevent the occurrence of a boiling-liquid-expanding-vapor explosion in the holding tanks. However, over time, the weak tank rims typical in the design of fixed-roof holding tanks would likely collapse or partially collapse under the intense heat coming from the dike fire. After the roof collapsed, a tank fire would rapidly ensue. The resulting crude oil tank fire could develop into very large "boilover" event that could spread the dike/tank fire outside secondary containment and/or to adjacent containment dike(s) within the East Tank Farm.

The protection of the second tank in a two-tank dike configuration is fundamental to containing and eventually extinguishing dike fires that may occur in the East or West Tank Farms. This can be done through a well planned and executed firefighting response strategy.

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3 Large fires involving volatile liquids such as crude can in time become very hot. The lighter and more volatile components (e.g., aromatics and PAHs) of crude on the surface are rapidly burned off and/or evaporated and burned. The less volatile components of the crude layer on top become denser and sink below the surface to be replaced by a more volatile layer, which is again burned off. This cycle, known as a "heat wave," continues, resulting in a deepening surface layer of very hot oil. The cycle terminates in an explosive boilover of the crude oil pool (as a result of the denser and hotter layer reaching water or water/oil emulsion at the bottom of the tank, which results in the superheated water or oil mixture subsequently flashing into steam and nearly explosive boiling).

Although details would need to be developed, one strategy would be to divide the dike into three zones and target foam application to the standing tank within the dike fire. The goal would be to provide a foam/water application rate sufficient to keep the tank cool and thereby prevent tank thermal failure. A concurrent action to consider would be, if feasible, to rapidly empty the crude oil in the second tank to an available vessel in berth. This could be done in less than 2 hours if the tank volume was less than 150,000 bbl of crude. It is also assumed that the tank's subsurface fire foam system[4] would be activated at the appropriate time to provide a surface vapor barrier on top of the crude oil in the tank. This barrier would reduce vapor emissions through the tank roof vents and prevent vapor ignition from the external fire. The Valdez Marine Terminal currently has a draft fire fighting strategy to keep adjacent tanks cool in a tank or dike fire (APSC 2002c).

The fire analysis presented in the DEIS analyzes an accepted, but very unlikely, scenario of a tank farm fire. The scenario is based on credible, current, and accepted assumptions on fires in tank farms, as well as on documented firefighting strategies and capabilities at the Valdez Marine Terminal. While it is maybe possible to speculate on other fire scenarios, information currently available is not adequate to conduct technical analyses of other worst-case events. Thus, the presentation of other worst-case fire scenarios would be highly speculative and uncertain and would not be supported with available, peer-reviewed technical information.

The JPO and BLM recognize that regardless of the adequacy of industrial firefighting capabilities, including specific firefighting response and mitigation actions, the outcome of a large dike fire at marine terminals or oil refineries is uncertain. Thus, plans and capabilities are in place to ensure life and safety protection, including evacuation of the facility. Because of a large number of uncertainties and the small probabilities of large dike fires, attachment of specific firefighting mitigation actions or requirements to the TAPS renewal would be premature at this time. However, the review of response and mitigation of potentially large fires that are credible but *very unlikely* events would be appropriate and well suited to those JPO member agencies (including the State of Alaska Fire Marshal, ADEC, EPA, and BLM) that have oversight, as established under current regulatory authority, for Valdez Marine Terminal fire planning and response.

Given the presence of an ignition source and the presence of vapors (in the vapor space above a flammable liquid) at concentrations within their flammability limits, a boilover event can occur with a large crude oil tank fire. Although it is likely that the vapor recovery system serving tank #1 fails during the initial aircraft impact into tank #2, a fire and boilover in tank #1 is assumed not to occur. The basis for this assumption is that the firefighters at the Valdez Marine Terminal would have the necessary specialized training and equipment required to fight large dike fires. This would include having industrial-type fire fighting apparatus and associated equipment (e.g., cannons/pumps with industrial ratings) and aqueous fire fighting foam. The appropriate level of training, foam inventories, and the size and number of foam cannons are critical to producing and sustaining the foam/water discharge rates required to achieve foam runs that can contain and extinguish large fires. In addition to the fire fighting strategy that is employed, it is assumed that the tank's subsurface fire foam system, in addition to the targeted foam application to the standing tank within the dike fire, would be sufficient to keep the tank cool enough and thereby prevent tank thermal failure and/or prevent the ignition of flammable vapors that would be generated in the vapor space at the top of tank. The Valdez Marine Terminal currently has a draft fire fighting strategy to keep adjacent tanks cool in a tank or dike fire (APSC 2002c). The crude oil in tank #1 one was assumed to be unaffected by the fire because of the quick response from a well-trained and well-equipped

4 A subsurface fire foam system is installed at both the East and West Tank Farms. The system includes pumps and motor-operated valves designed to create and direct foam inside a tank in case of a fire. Fixed pipes at the bottom of the tank distribute foam radially through a "spider" piping system installed in each tank, near the tank bottom. This system is designed to disperse foam that would float to the top of the burning crude oil surface and extinguish a fire (APSC 2002b).

Valdez Marine Terminal fire brigade, with support as necessary, from the Valdez Fire Department.

4.4.3.2 Pipeline Fire Scenario

Pipeline Scenario 19b assumes a guillotine break in the pipeline as the result of a direct impact from an aircraft taking off from the Fairbanks International Airport approximately 19 km from the pipeline. The impact from the crash and the resulting fire were assumed to occur somewhere between TAPS MP 456 through 458. A large crude oil fire ignites and burns as oil continues to spill from the break in the pipeline. A total of 42,101 bbl or 5.8 million kg of crude oil spills at this pipeline location and burns in a pool fire for about 30 min. The heat release rate from this fire is 141.2 GW. The spill is unconfined (i.e., no containment barriers, berms, bunds, or dikes) and is estimated to exit the broken pipe at a constant rate of 1,458.3 bbl/min (based on a 2.1-million bbl/d throughput, Folga et al. 2002). The extent of spill spread on the ground is limited by the North Slope crude oil burn rate of 0.051 kg/s-m^2. At the given continuous spill rate for the pipeline guillotine break, the crude oil would continue to spread until the total burning rate is equal to the spill rate. When this equilibrium is reached, the fire pool spread or pool diameter can be estimated with the empirical formula given by Mudan (1984).[5] The resulting equilibrium pool diameter is 289.7 m, with an estimated pool area of 65,912 m^2. This pool fire area is about twice the size of the confined dike fire spill in Scenario 10 for the Valdez Marine Terminal.

In contrast to weather conditions occurring at Valdez, more frequent unstable atmospheric conditions are observed at Fairbanks with larger mixing layer depths. Fire air quality impacts for four meteorological conditions were assessed with the FIREPLUME model. Case 1 assumed moderately unstable conditions (stability Class B) with a 2 m/s wind speed and a 2,400-m inversion layer height; Case 2 assumed slightly unstable conditions (stability Class C) with a 5 m/s wind speed and a 1,750-m boundary layer height. Case 3 was run with near neutral weakly stable conditions (stability class D/E) with a 10 m/s wind speed and a 1,500-m mixing height. Finally, Case 4 assumed slightly stable or weakly neutral conditions (stability Class E/D) with and a 7 m/s wind speed and a 700 m mixing height.

The buoyancy parameters derived from the Fairbanks FDS model assumed flame heights similar to the Valdez Marine Terminal fire. The FDS-computed average fire temperature at an effective release of 100 m was 223.5°C. The predicted FIREPLUME maximum soot and other combustion product concentrations and distances downwind from Fairbanks for these two cases are given in Table 4.4-9. The averaging time for the estimated concentrations is based on the dike fire burn time. Assuming the same crude oil burn rate of 0.051 kg/m^2-s (38 lb/h/ft^2), as used for the Valdez fire, the Fairbanks pipeline fire would be estimated to burn for around 30 min before self-extinguishing. The greatest soot and other combustion product impacts occur under moderately unstable conditions at distances greater than 30 km downwind of the pipeline guillotine break. The predicted FDS model concentrations at the specified downwind distance from the fire are summarized in Table 4.4-10. These concentrations account for fire-induced wind-field effects on the smoke plume. Exposure health impacts to workers are discussed in Section 4.4.4.7.

4.4.4 Impacts of Spills on Environmental Receptors

4.4.4.1 Soils and Permafrost

4.4.4.1.1 Spills on Land. Surface soil near the TAPS ROW could be affected by spills on the land. The most immediate potential impact would be direct contamination of the soil.

5 The empirical formula to calculate the fire pool spread or pool diameter is given by Mudan (1984): $d_p = V_S / (\pi B_V)^{0.5}$, where V_S = 3.86 m^3/s is the crude oil volume spill rate and $B_V = 5.86 \times 10^{-5}$ m/s is the burn velocity.

TABLE 4.4-9 Maximum Public Exposures to Soot and Fire Combustion Products, Pipeline Scenario 19b

		Combustion Product (30-min averages)							
Case	Downwind Distance (km)	TSP (mg/m^3)	PM_{10} (mg/m^3)	CO (mg/m^3)	NO_x (mg/m^3)	SO_2 (mg/m^3)	VOC (mg/m^3)	PAH (mg/m^3)	CO_2 (mg/m^3)
1 (B2)[a]	37.5	0.608	0.555	0.122	4.05×10^{-3}	0.101	2.03×10^{-2}	4.05×10^{-4}	11.4
2 (C5)	> 50	3.03×10^{-2}	2.76×10^{-2}	6.05×10^{-3}	2.02×10^{-4}	5.05×10^{-3}	1.01×10^{-3}	2.02×10^{-5}	0.567
3 (D/E10)	> 50	0.106	9.66×10^{-2}	2.11×10^{-2}	7.05×10^{-4}	1.76×10^{-2}	3.52×10^{-3}	7.05×10^{-5}	1.98
4 (E/D7)	> 50	0.190	0.173	3.79×10^{-2}	1.26×10^{-3}	3.16×10^{-2}	6.32×10^{-3}	1.26×10^{-4}	3.55

[a] The information in parentheses is the stability class and wind speed.

Impacts of Oil Spills on Soils and Permafrost

Surface soil near the TAPS ROW could be affected by spills on the land. The most immediate potential impact would be direct contamination of the soil. Prompt cleanup efforts could reduce the spread of contaminants. However, the disturbance of surface vegetative cover during cleanup activities could impact the permafrost below. Depending on locations, spill volumes, and spill scenarios, the extent of contaminated land area due to a spill could range from 0.15 acre to 84 acres.

Prompt cleanup efforts could reduce the spread of contaminants. However, the disturbance of surface vegetation cover during cleanup activities could impact the permafrost below (see Section 4.3.2). This section discusses the potential extent of land contaminated from spills under various spill scenarios.

Several factors control the spread of spilled crude oil on land. Once a spill occurs, the light components in the crude oil evaporate. For most crude oils (medium oils), about one-third of the oil can evaporate within 24 hours. The rate of evaporation can be affected by weather. Low temperatures reduce the evaporation rate, while high winds increase it. The terrain and the surface features of a spill site, as well as human response to a spill, control the spreading of the rest of the spilled oil.

On a sloped terrain, part of the spilled oil flows downslope; the remainder infiltrates to the subsurface or is absorbed or coats vegetation or snow. The downslope spreading of the oil is partly restrained by the viscous drag on the crude oil from contact with the ground surface and vegetation, liquid surface tension, and local depressions. Downward infiltration of the oil into the soil depends on the permeability of the ground surface, which, in turn, is controlled by the texture of local soil and the presence of snow, permafrost, and the water table. A frozen soil has a low permeability that limits downward infiltration. Downslope spreading dominates the spreading process until the oil is intercepted by either human intervention or natural features, such as depressions, rivers, streams, ponds, or lakes. If an anthropogenic structure, such as a workpad, access road, or highway, is in the path of a migrating oil plume, it can divert the flow. In addition, spilled oil can spread laterally as it moves downslope. The magnitude of the lateral spreading increases with decreasing slope.

On a flat terrain, such as in the Arctic Coastal Plain, the slope is of less importance in controlling the spreading of a spill. Local surface features, such as depressions on patterned ground and vegetative cover, would control the extent of a spill.

TABLE 4.4-10 Maximum Public Exposures to Soot and Fire Combustion Products Close to the Fire, Pipeline Scenario 19b

	Centerline Concentrations (15-min averages)							
Distance (m)	PM_{10} Soot (mg/m^3)	TSP (mg/m^3)	CO (mg/m^3)	NO_x (mg/m^3)	SO_2 (mg/m^3)	VOC (mg/m^3)	PAH (mg/m^3)	CO_2 (mg/m^3)
150	43.1	47.2	9.44	0.315	7.86	1.57	3.15×10^{-2}	884
200	54.1	59.2	0.118	0.395	9.87	1.97	3.95×10^{-2}	111
250	42.7	46.8	9.35	0.312	7.79	1.56	3.12×10^{-2}	876
300	17.5	19.2	3.83	0.128	3.19	0.639	1.28×10^{-2}	359
350	6.27	6.9	1.37	4.58×10^{-2}	1.14	0.229	4.58×10^{-3}	129
400	3.67	4.0	0.804	2.68×10^{-2}	0.670	0.134	2.68×10^{-3}	75.3
450	1.48	1.6	0.324	1.08×10^{-2}	0.270	5.40×10^{-2}	1.08×10^{-3}	30.4
500	1.48	1.6	0.324	1.08×10^{-2}	0.270	5.40×10^{-2}	1.08×10^{-3}	30.4
600	0.82	0.90	0.180	5.99×10^{-3}	0.150	2.99×10^{-2}	5.99×10^{-4}	16.8
700	0.287	0.31	6.28×10^{-2}	2.09×10^{-3}	5.24×10^{-2}	1.05×10^{-2}	2.09×10^{-4}	5.89
800	0.123	0.13	2.69×10^{-2}	8.98×10^{-4}	2.24×10^{-2}	4.49×10^{-3}	8.98×10^{-5}	2.52
900	7.26×10^{-2}	7.95×10^{-2}	1.59×10^{-2}	5.30×10^{-4}	1.32×10^{-2}	2.65×10^{-3}	5.30×10^{-5}	1.49
1,000	2.71×10^{-2}	2.97×10^{-2}	5.93×10^{-3}	1.98×10^{-4}	4.95×10^{-3}	9.89×10^{-4}	1.98×10^{-5}	0.556
1,100	7.07×10^{-3}	7.74×10^{-3}	1.55×10^{-3}	5.16×10^{-5}	1.29×10^{-3}	2.58×10^{-4}	5.16×10^{-6}	0.145
1,200	1.37×10^{-3}	1.50×10^{-3}	3.00×10^{-4}	1.00×10^{-5}	2.50×10^{-4}	5.00×10^{-5}	1.00×10^{-6}	2.81×10^{-2}
1,300	5.44×10^{-4}	5.96×10^{-4}	1.19×10^{-4}	3.97×10^{-6}	9.93×10^{-5}	1.99×10^{-5}	3.97×10^{-7}	1.12×10^{-3}
1,400	3.26×10^{-4}	3.57×10^{-4}	7.14×10^{-5}	2.38×10^{-6}	5.95×10^{-5}	1.19×10^{-5}	2.38×10^{-7}	6.69×10^{-3}

The methodology used to estimate the size of a spill site on land is described in Section 4.4.1. In general, if the location of a spill is not specified, the size of the contaminated area created by the spill is estimated by dividing the volume of the spill by an assumed depth of the spilled liquid pool (1, 2, or 3 in.). If the TAPS milepost of a spill is specified, however, an objective analysis method (see Section 4.4.1) is used, if appropriate, to estimate the size of the spill area.

4.4.4.1.2 Impacts for Selected Spill Scenarios.

Anticipated Spills. *Anticipated* spills are defined as spills caused by events with an expected frequency range of 0.5/yr or more (Tables 4.4-1 and 4.4-2). The scenarios include six types of small leaks that could cause a land-based release of 0 to 50 bbl (0 to 2,100 gal) of crude oil, 0 to 100 bbl (0 to 4,200 gal) of diesel fuel, 0 to 3 bbl (0 to 126 gal) of gasoline, or 0 to 50 bbl (0 to 2,100 gal) of turbine fuel. The worst event among the anticipated spill scenarios would be an instantaneous leak of 100 bbl of diesel fuel during pipeline or pump station operations. On the basis of the parametric method, the maximum size of the potentially contaminated area would be about 0.15 acre. This level of impact on soils would be very small and local. Prompt cleanup would reduce the impacts to negligible.

Likely Spills. *Likely* spills are defined as spills caused by events with an expected frequency range of 0.03 to 0.5/yr (Tables 4.4-1 and 4.4-2). The scenarios evaluated represent 10 types of events that could cause a land-based release of 50 to 10,000 bbl (2,100 to 420,000 gal) of crude oil, 100 to 200 bbl (4,200 to 8,400 gal) of diesel fuel, 3 to 100 bbl (126 to 4,200 gal) of gasoline, or 50 to 200 bbl (2,100 to 8,400 gal) of turbine fuel. The worst event in this category would be a leak caused by sabotage or vandalism that might cause the release of 10,000 bbl of crude oil over a period of 48 hours (Table 4.4-1). This event is used to evaluate the maximum impact in the likely spill category.

To ensure that the evaluation results would not underestimate the consequences, a release of 10,000 bbl of oil onto the ground was assumed. The maximum extent of spreading would be expected if no interceptor was present near a spill site. On the basis of the parametric method (see Section 4.4.1), the maximum potentially contaminated area would be about 15 acres at an assumed oil pool depth of 1 in. Because of the small size, this impact on soils would be small and localized if prompt cleanup occurred after the spill.

Unlikely Spills. *Unlikely* spills are defined as spills caused by events with expected frequencies of 10^{-3} (0.001) to 0.03/yr (Tables 4.4-1 and 4.4-2). The scenarios evaluated include six types of events that could cause a land-based release of crude oil ranging from 50 to about 54,000 bbl (2,100 to 2,268,000 gal), depending on both the location of the spill and the throughput of the pipeline. The worst event in this category would be a guillotine break from the impact of an aircraft. Up to 54,000 bbl of crude oil could be released in a short period of time. This scenario was used to evaluate the maximum impact for the unlikely spill category.

For the unlikely spill scenarios, because the potential release volume would be the same as the volume for the very unlikely spill scenarios and because potential release sites are not specific, the maximum size of a potentially contaminated area would be expected to be the same (84 acres) as that evaluated below for the very unlikely spill category.

Very Unlikely Spills. *Very unlikely* spills are defined as spills caused by events with an expected frequency range of 10^{-6} (0.000001) to 10^{-3}/yr (Tables 4.4-1 and 4.4-2). The scenarios evaluated for this category of spill include nine types of events that could cause a land-based release of a volume of crude oil ranging from 700 to about 54,000 bbl (29,400 to 2,268,000 gal), depending on both the location of the spill and the throughput of the pipeline at the time of the spill. The worst event in the very unlikely spill category would be a guillotine break of the pipeline from the impact of a helicopter. Up to 54,000 bbl of crude oil could be released in a short period of time. This scenario is used to evaluate the maximum impact in the very unlikely spill category.

Table 4.4-5 summarizes the estimated maximum land-based spill areas in various locations, including earthquake-prone areas, wild and scenic areas, population centers, and representative areas with different types of terrestrial wildlife habitats along the TAPS. Among the locations, the Goldstream Creek area (MP 448–453) would experience the maximum release under the very unlikely spill scenario of a guillotine break of the pipeline: 53,565 bbl (2,249,730 gal) of crude oil released aboveground in a short time for a pipeline throughput of 2.1 million bbl/d (Table 4.4-5). On the basis of the parametric method of calculation (see Section 4.4.1), the estimated size of a potentially contaminated area would be 84 acres for the 2.1 million-bbl/d throughput and an assumed spill pool thickness of 1 in. (Table 4.4-5). However, the pipeline in this area is adjacent to a creek. Crude oil released in this area would drain into the creek, resulting in a smaller contaminated land area of about 0.2 acre (as reported in the results from using the objective analysis, see Section 4.4.1). The majority of the contaminated land would be confined along the creek and downstream.

To estimate the maximum size of a potentially contaminated land-based area for the very unlikely spill scenarios, both release volume and local terrain were considered. At locations with no nearby interceptors, the spreading of spilled oil would be limited by the quantity of a spill. The maximum volume of a land-based spill is estimated to be about 54,000 bbl (see above). On the basis of the parametric method, which ignores land surface features, vegetation, and snow presence, the maximum size of a potentially contaminated area is expected to be less than 84 acres for the very unlikely spill scenarios. The impact on soils would be small and localized if containment and cleanup was prompt after the spill.

4.4.4.2 Paleontology

In most cases, no adverse effects to paleontological resources are anticipated to result from oil spills from the pipeline, from Valdez Marine Terminal operations, or from associated transportation. Although some paleontological resources have been discovered near the TAPS ROW, these materials, if they were Pleistocene or Holocene in age, were removed upon discovery. The greatest risk to any previously undiscovered paleontological material remaining in the vicinity of the TAPS would likely be from heavy machinery used during spill containment and remediation activities rather than from the spill itself. No studies are known of the adverse effects of crude oil on petrified or nonpetrified paleontological material. One potentially adverse effect from crude oil on nonpetrified paleontological materials would be from hydrocarbon contamination, which may preclude age determination by means of radiocarbon dating and other types of chemical analyses. The likelihood of such an effect is very low, given that (1) there are only two known locations where Pleistocene-age vertebrate fossils were found in proximity of the ROW, and (2) the general improbability of a spill at or near (i.e., upstream of) those specific locations.

Impacts of Oil Spills on Paleontological Resources

Oil spills from the pipeline, Valdez Marine Terminal, or transportation would not be expected to adversely affect paleontological resources. There is a potential for oil contamination to adversely affect nonpetrified paleontological materials, although to date no studies have addressed this concern.

4.4.4.3 Surface Water Resources

4.4.4.3.1 Introduction. The spill scenarios evaluated for this DEIS were divided into four frequency ranges: *anticipated, likely, unlikely,* and *very unlikely* (Section 4.4.1.1). Because these ranges are applicable for the overall length of the pipeline, the frequency of occurrence for any spill scenario at a specific location would be much less than for the pipeline as a whole. For example, a guillotine break caused by a helicopter crash into the pipeline is estimated to occur at a frequency of approximately 2.9×10^{-5} along the entire length of the pipeline. However, the frequency of such an accident occurring in buried portions of the pipeline is zero. The frequency of occurrence along any 1-mi stretch of the aboveground portions of the pipeline is on the order of 1 in 10 million (6.9×10^{-8}), and the frequency of such a spill occurring at a bridge with a length of 300 ft would be (6.9×10^{-8}) × 300/5280), or about 3.9×10^{-9} (1 in 255 million). Similarly, the overall frequency of occurrence for a likely corrosion-related leak is 0.038 along the entire pipeline. However, the maximum frequency of a corrosion-initiated leak along any 1-mi stretch of the pipeline is much less, about 5×10^{-5}, or about 1 in 20,000.

Impacts of Oil Spills on Surface Water Resources

Anticipated accident scenarios involving small spill volumes could release sufficient crude oil to produce substantial contamination problems for such rivers as the Gulkana, which is designated as a Wild River. For these types of spills, impacts could be minimized by proper planning, training, surveillance, and timely implementation of contingency activities.

Impacts to surface waters could be major and extensive in the event of a guillotine break of the pipeline at an elevated river crossing. Scenarios were evaluated for such breaks caused by a helicopter or fixed-wing aircraft crashing into the pipeline at such a crossing. Such an event is judged to have a very low probability of occurrence. However, if it did occur, 54,000 bbl of crude oil could be released. Many miles of river banks and beds could be coated with oil, requiring long-term cleanup efforts.

Crude oil spills along the TAPS ROW could affect surface water resources, particularly if the spill occurred directly to water (e.g., at an elevated river or stream crossing), or in a location in which the spilled oil could enter a river or stream after flowing across a land surface. Because the impacts produced by a spill of a given volume would be greatest for a direct spill to water, the analyses presented here for surface water impacts assume that the spilled oil is discharged directly to water. Impacts to water for the same spill occurring over land followed by surface flow to water would be accordingly smaller because of losses of oil on the ground.

In northern areas, the presence of ice can complicate and modify the movement and spreading of an oil slick (Overstreet and Galt 1995). Oil spilled under a solid ice sheet tends to form lenses that can remain relatively thick. Currents in the flowing water can move the oil lenses along the underside of the ice in paths that are difficult to analyze. If the ice is broken, oil can float up in the small water channels between pieces of ice and spread over large areas. Because of the inherent complexity of such situations and the need for site- and time-dependent information to calculate impacts, spills to broken ice or beneath ice sheets are not analyzed; however, the impacts would be bounded by the calculations performed for open water. Impacts of spills to the top of a thick ice sheet would be similar to impacts of a spill on frozen ground.

4.4.4.3.2 Impacts of Spill Scenarios. Impacts to surface water resources from the postulated spill scenarios are discussed in this section by their occurrence frequency, starting with impacts produced by spills that are *anticipated* (frequency of occurrence greater than 0.5/yr). Four scenarios that could affect inland surface waters are included in this range: a small leak of crude oil (Scenario 1); a small leak of diesel fuel (Scenario 2); a small leak of gasoline (Scenario 3); and a small leak of turbine fuel (Scenario 4). Of these four scenarios, a small leak (50 bbl) of crude oil is the only scenario that could directly affect surface water resources. The other spill scenarios would occur only at pump stations or at valves.

The second frequency analyzed is for accidents that are described as *likely* (frequency of occurrence of 0.03 to 0.5/yr). This category includes eight spill scenarios that could affect inland surface water resources: a moderate leak of crude oil (Scenario 5); a moderate leak of diesel fuel (Scenario 6); a moderate leak of gasoline (Scenario 7); a moderate leak of turbine fuel (Scenario 8); a leak resulting from maintenance-related damage (Scenario 9); a leak caused by pipeline overpressurization from inadvertent remote gate valve operation (Scenario 10); a leak caused by sabotage or vandalism (Scenario 12); and a leak caused by corrosion-related damage (Scenario 14). Two scenarios would produce the same and greatest impacts: a leak caused sabotage or vandalism (Scenario 12), and a leak caused by corrosion-related damage (Scenario 14). Both scenarios would have a maximum release of 10,000 bbl of crude oil over a prolonged period.

The third frequency range evaluated is for accidents that are *unlikely* (frequency of occurrence of 1×10^{-3} to 0.03/yr) (Section 4.4.1). Four accidents that could affect inland surface water resources are classified as unlikely: a valve leak caused by gasket failure or large packing leak (Scenario 11); a crack resulting from seismic fault displacements and ground waves (Scenario 16); a guillotine break caused by a fixed-wing aircraft crash without fire (Scenario 19a); and a fixed-wing aircraft crash with fire (Scenario 19b). Of these accidents, the one that would cause the greatest impact to surface water resources is the one that would release the largest volume of oil. This accident is a guillotine break of the pipeline from the impact of a fixed-wing aircraft (Scenario 19a). This accident would release a maximum of about 54,000 bbl of oil.

The last frequency range of spill scenarios is described as *very unlikely* to occur (frequency of occurrence of 1×10^{-6} to 1×10^{-3}/yr) (Section 4.4.1). Five scenarios are included in this frequency range that could affect inland surface waters: a prolonged leak caused by washout damage resulting from close proximity to a stream or river (Scenario 13); a catastrophic tank loss at a pump station (Scenario 17); a guillotine break of the pipeline caused by the impact of a large truck (Scenario 18); a guillotine break caused by a seismically induced landslide (Scenario 20); and a guillotine break caused by the impact of a helicopter (Scenario 21). Of these scenarios, a helicopter crash into the pipeline at an elevated river crossing would produce the largest impact to surface water resources because it would release the largest volume of oil (about 54,000 bbl). Because the volume of oil that would be released by this accident would be the same as that released by a fixed-wing aircraft crash into the pipeline (Scenario 19a), the impacts would be the same.

The analyses performed to determine the impacts of the spill scenarios mentioned above depend on a number of estimated and measured quantities: the volume of fluid spilled during an event, the time needed for the fluid to discharge to the environment, the velocity of the current in the receiving river that would transport the fluid downstream, and the response time required to initiate appropriate contingency measures (see Section 3.7).

It is assumed that once the crude oil was in flowing water, it would move downstream with distinct leading and trailing edges (plug flow) and a slick length that remained constant in time. Circular spreading is assumed to occur until the slick reaches a shoreline (Appendix A, Section A.15.2). More complex processes are not included in the analyses because insufficient site-specific information is available to perform more detailed modeling. Processes not considered in the analysis include multidimensional mechanical spreading caused by the balance between gravitational, viscous, and surface-tension forces; horizontal turbulent diffusion (spreading driven by a difference in concentration); evaporation; dissolution; shoreline deposition; and photochemical and biological degradation. In addition, the effectiveness of remediation activities once a slick is either contained or diverted to an appropriate containment site is not evaluated. Instead, the percentage of released oil subject to recovery is calculated as a measure of response effectiveness for each of the designated spill scenarios.

Anticipated Spill Events. The first frequency range of spill scenarios analyzed is described as *anticipated*. A small leak of crude oil would produce the greatest impact on surface water resources (Scenario 1) because it would release the greatest volume of oil to the environment (50 bbl, or 2,100 gal). Other spill scenarios in this category (e.g., spills of fuel oil and gasoline) would not produce direct impacts to surface water resources because they would occur at pump stations or valves that have no direct contact with rivers or creeks.

Table 4.4-11 lists some of the major and minor elevated river crossings where a direct spill to water could occur. Six of the elevated river crossings listed in Table 4.4.4.3-1 were selected for evaluation for this DEIS:

- Dan Creek/Sagavanirktok River (MP 85),
- Yukon River (MP 353–354),
- Minton Creek (MP 510),
- Tanana River (MP 531–532),
- Gulkana River (654–655), and
- Tazlina River (MP 686–687).

These crossings were selected because the rivers are classified as anadromous or Wild and Scenic, or both (see Section 3.7.1), and they represent rivers in different hydrologic regions of the TAPS ROW (North of the Brooks Range, the Interior, and Glennallen to Valdez Hydrologic Regions, (see Section 3.7). Minton Creek was included because it would receive the largest quantity of crude oil in a guillotine break scenario. Because the Dan Creek crossing is located very near to the Sagavanirktok River (less than 500 ft away), calculations were performed by using the properties of the Sagavanirktok River to obtain conservative results.

Table 4.4-12 summarizes information on flows and physical characteristics for the six elevated crossings and on designated containment sites from the appropriate contingency plans (APSC 2001m). The containment site distance given in the table is the distance from the location of the spill to the location where the oil would be contained (i.e., the designated containment site provided in the contingency plan).[6] The velocities of the surface currents listed are assumed to be the same as the river velocities provided in the contingency plans.

The anticipated spill is assumed to occur instantaneously (very short duration spill). Spill times for analyses were obtained by dividing the release volume by the daily throughput of the pipeline. For throughputs of 0.3 million, 1.1 million, and 2.1 million bbl/d, the release times are about 14, 4, and 2 seconds, respectively. For this spill, the oil slick would be short under plug-flow assumptions. The longest slicks would occur on the Tanana and Tazlina Rivers. For a current velocity of 10 ft/s (Table 4.4-12), a 140-ft-long slick would be produced for a throughput of 0.3 million bbl/d.

The approximate times for a response team to get to the location of the designated containment site and initiate an appropriate response for an anticipated event are listed in Table 4.4-13 (Folga et al. 2002). The sequence of events involved in getting a response team to the designated containment site and initiating oil-recovery procedures is summarized as follows:

- Leak detection system goes into alarm,
- Dispatcher recognizes that a leak is occurring and notifies appropriate pump station
- The OCC requests the pump station to conduct reconnaissance,
- A helicopter is mobilized, or vehicles dispatched, as needed, for reconnaissance,
- Reconnaissance conducted to confirm the presence of an oil leak,

6 Responses are not restricted to these containment sites. Response activities would take place at suitable locations identified at the time of the spill. However, these designated sites are assumed for the purpose of the anlaysis presented here.

TABLE 4.4-11 Approximate Maximum Oil Discharges (bbl) at Major and Minor Elevated River Crossings Produced by a Guillotine Break in the Pipeline

		Maximum Oil Discharge (bbl) by Throughput Level (bbl/d)		
Name	Milepost	0.3×10^6	1.1×10^6	2.1×10^6
Dan Creek/Sagavanirktok River	85	28,998	29,880	31,662
Atigun River	141	27,916	28,573	29,393
Atigun River	147	17,521	18,506	19,737
Snowden River	198–199	34,932	37,846	33,922
Dietrich River/floodplain	200	34,932	37,846	33,922
Dietrich River	205–206	37,028	39,858	36,296
Middle Fork Koyukuk River/floodplain	208–213	23,730	26,519	23,057
Linda Creek	215	24,473	27,164	24,006
Sheep Creek	216–217	27,120	29,797	26,647
Nugget Creek	217	31,254	33,921	30,774
Middle Fork Koyukuk River/floodplain	221	32,726	35,336	32,257
Hammond River	222	20,595	23,187	19,834
Middle Fork Koyukuk River/floodplain	222–225	23,261	25,809	22,843
Minnie Creek	226	23,261	25,809	22,843
Middle Fork Koyukuk River/floodplain	228–233	35,310	37,792	34,889
Clara Creek	236	24,219	26,617	23,734
Middle Fork Koyukuk River/floodplain	242–246	32,804	35,075	32,241
South Fork Koyukuk River	256	26,479	28,591	25,959
Douglas Creek	270	23,041	24,964	22,323
Prospect Creek	277	36,610	38,430	31,940
Yukon River	353–354	20,477	21,246	17,676
Hess Creek	378–379	37,727	38,148	33,692
Erickson Creek	387–388	28,122	28,410	31,714
Lost Creek	392	32,561	32,779	28,467
Tolovana River	398–399	28,803	28,938	38,079
Tatalina River	412–413	23,723	23,662	27,823
Globe Creek	417	43,888	38,222	39,451
Aggie Creek	423–425	25,722	20,710	21,978
Washington Creek	431–432	18,584	30,440	31,518
French Creek	474–484	28,945	31,593	31,315
Little Salcha River	490–491	21,292	23,573	20,276
Redmond Creek	500	29,388	31,813	33,948
Minton Creek	510	52,390	53,967	50,561
Shaw Creek	520–521	23,550	24,828	31,833
Tanana River	531	7,489	8,486	11,612
Castner Creek	587–588	15,964	17,129	15,499
Lower Miller Creek	588	15,964	17,129	15,499
Miller Creek	589–590	13,143	14,336	12,737
Gulkana River	654–655	26,308	27,930	24,690
Tazlina River	686–687	17,334	18,291	15,871
Rock Creek	712	32,940	33,530	31,691
Squirrel Creek	717	20,468	20,992	19,260

TABLE 4.4-12 River Parameters for Spill Analyses

Location	Milepost	Contingency Area	Segment	Containment Site (CS) (mi)	Velocity (ft/s)	Discharge (ft^3/s)	Comments
Dan Creek/ Sagavanirktok River	85	Sagavanirktok River 2	2	CS 2-0 13.6 mi	2 to 8	2,000 to 28,000	CS2-1 containment site also possible, but very near crossing; heavy braiding; diversion booms with pits (low flows), underflow dams in side channels, blocking dams in high water channels.
Yukon River	353	Yukon	4	CS 5-26 1mi CS 5-29 4 mi	3 to 8	150,000 to 800,000	Single confined channel; Edward L. Patton Bridge; 1,500 to 4,000 ft wide; diversion booms.
Minton Creek	510	Salcha	5	CS 8-7A 12 mi	1 to 4	5 to 150	Incised channel; 2 to 20 ft wide with dense grass and willows and beaver dams; blocking dams and underflow dams.
Tanana River	531	Big Delta	3	CS 8-16 4 mi	3 to 10	15,000 to 60,000	Incised with narrow floodplain before Richardson Highway Bridge; braided after with several channels and gravel bars; 200 to 4,000 ft wide; diversion boom with underflow dams in small channels; contain in braided segment.
Gulkana River	654	Gulkana	3	CS 10-16 (17?) 20 mi at south abutment of old Richardson Highway Bridge	1 to 7	600 to 12,000	Near entry to Copper; 150 to 400 ft wide; meandering pattern with single channel; gravel bars at low flows; diversion booms and berms.
Tazlina River	686	Tazlina	4	CS 10-20 5 mi	2 to 10	2,000 to 26,000	6 mi to Copper; 250 to 600 ft wide; meandering pattern in broad valley; diversion booms and pits.

TABLE 4.4-13 Estimated Response Times for Various Spill Locations and a Guillotine Pipeline Break

Location	Nearest Milepost	Contingency Area	Nearest Pump Station	Distance to Nearest Pump Station (mi)	Estimated Response Time (h) Worst Case	Average	Best Case
Dan Creek/ Sagavanirktok River	85	Sagavanirktok River 2	PS 3	33	12	5	5
Yukon River	353	Yukon	PS 6	4	9	3	3
Minton Creek	510	Salcha	PS 8	5	12	5	4
Tanana River	531	Big Delta	PS 9	20	14	7	7
Gulkana River	654	Gulkana	PS 11	13	10	4	4
Tazlina River	686	Tazlina	PS 12	35	10	5	4

- The maintenance coordinator notifies the OCC and pump station personnel of leak and requests that containment equipment be dispatched,
- Pump station personnel and equipment are mobilized,
- Crews are dispatched from the pump station to containment site, and
- Booms and other equipment are deployed to contain the spill.

With the oil slick created by the spill traveling at the velocity of the river (Table 4.4-12), the leading edge of the slick could be many miles downstream of the break by the time containment and cleanup could be initiated for both high- and low-flow conditions in the receiving waters (Table 4.4-14). Because of the small volume of the spill, however, it is unlikely that the oil would be able to reach all of these containment locations, particularly those under high-flow conditions.

The percentages of oil subject to recovery at the containment sites were calculated on the basis of the assumptions of plug flow and volumetric balances as detailed in (Appendix A, Section A.15.2). The results are presented in Table 4.4-15. Except for the Dan Creek/ Sagavanirktok River, Minton Creek, and the Gulkana River crossings at low flow, all of the containment sites would fail to capture the crude oil if it flowed downstream as a plug flow. For Dan Creek/Sagavanirktok River, Minton Creek, and the Gulkana River, 100% of the released fluid would be subject to capture.

TABLE 4.4-14 Location of the Leading Edge of the Oil Slick at Estimated Response Times

Water Body	Distance (mi) Downstream of Release Point: High-Flow Conditions	Low-Flow Conditions
Dan Creek/ Saganvanirktok River	27.5	7.0
Yukon River	16.5	6.3
Minton Creek	13.5	3.4
Tanana River	47.6	14.7
Gulkana River	19.2	2.8
Tazlina River	34.0	7.0

Because the crude oil would not move downstream as a plug, the physical size of the contaminated zone would be larger than the length of the plug-flow slick because of hangup along the flow path, mixing, entrainment, and remobilization. Although the volume of oil released is very small compared with the other spill scenarios, it would still be sufficient to create contamination problems downstream of the break, particularly in the Gulkana National Wild River.

TABLE 4.4-15 Summary of Spill Results for a Worst-Case Anticipated Spill Scenario

Location	Average Response Time (h)	High-Flow Velocity (mph)	Low-Flow Velocity (mph)	CS (mi)	Time to Reach CS for High Flow (h)	Time to Reach CS for Low Flow (h)	Spill Duration (h)	Percentage of Spill Subject to Recovery at CS for High Flow	Percentage of Spill Subject to Recovery at CS for Low Flow
Dan Creek/ Sagavanirktok River	5	5.5	1.4	13.6	2.5	9.7	0	0	100
Yukon River	3	5.5	2.1	4	0.7	1.9	0	0	0
Minton Creek	5	2.7	0.7	12	4.4	17.1	0	0	100
Tanana River	7	6.8	2.1	4	0.6	1.9	0	0	0
Gulkana River	4	4.8	0.7	20	0.6	28.6	0	0	100
Tazlina River	5	6.8	1.4	5	4.2	3.6	0	0	0

Likely Spill Events. The second frequency class analyzed was for spill scenarios described as *likely*. The scenarios in this category that would produce the greatest impact on surface water resources would be a leak caused by sabotage or vandalism (Scenario 12) and a leak resulting from corrosion-related damage (Scenario 14). These scenarios would produce the greatest impacts because they would release the largest volume of oil — 10,000 bbl (420,000 gal) over a prolonged release period. For purposes of analysis, the oil is assumed to spill directly into one of the previously discussed six rivers or streams at an elevated crossing.

Table 4.4-16 summarizes the duration of these spills and the response times for recovery at the six river crossings. The spill times range from 10 to 102 hours for a corrosion-related spill and from 11 to 105 hours for vandalism. The range of time is determined by the size of the hole in the pipeline (Folga et al. 2002). The spill times for the oil for the two scenarios are assumed to be the same (approximately 10 to 100 hours). Under average conditions, the response times listed in Table 4.4-16 range from 2 to 6 hours; under worst-case conditions (i.e., the spill is not readily detected), the response times are much longer, 31 to 36 hours.

Because the response times for a likely spill event (Table 4.4-17) (Folga et al. 2002) are different from those of an anticipated spill event (Table 4.4-13), the leading edge of the oil spill would be at a different locations for the given response times. For high-flow conditions, these distances are 22.0, 11.0, 10.8, 40.8, 14.4, and 27.2 mi for the Dan Creek/Sagavanirktok River, Yukon River, Minton Creek, Tanana River, Gulkana River, and Tazlina River, respectively. Under low-flow conditions, the distances would be 5.6, 4.2, 2.8, 12.6, 2.1, and 5.6 mi, respectively. The slicks would be wide enough to extend from bank-to-bank for all of the rivers and creeks evaluated (Appendix A, Section A.15.2). The tails of the slicks would not pass the containment sites for at least 10 hours, the minimum duration time of the spill, if the containment site was located at the spill location.

The percentage of oil subject to capture at the containment sites was again calculated by using plug-flow assumptions and volumetric balances (Appendix A, Section A.15.2). For these calculations, an average response time for the initiation of recovery was assumed. This assumption is reasonable for the likely spill scenarios because detection of oil spilling directly into one of the six rivers would be readily detected. The results of this analysis for a small hole (an emptying time of about 100 hours) are given in Table 4.4-17. On the basis of plug-flow assumptions, at least 95% of the released oil would be subject to recovery at the containment sites for each river. In the worst case (Tanana River and high-flow conditions), 50 bbl (2,100 gal) of oil would flow beyond the containment site without being subject to recovery. If the response time increased to the worst-case values, less of the oil would be subject to capture. For example, at Minton Creek the percent of spilled oil subject to recovery at the containment site would decrease from 100% to 70% if the response time increased from an average value of 4 hours to a worst-case value of 34 hours.

Table 4.4-18 shows the results of the calculations for the likely spill scenarios for a large-diameter hole (emptying time of 10 hours) with all of the other factors remaining the same. Under high-flow conditions on the Tanana River, 46% of the spilled oil would be subject to recovery at the containment site under conditions of plug flow, but 5,400 bbl (226,800 gal) would potentially move past the containment point before initiation of recovery. The percentage of oil subject to recovery at the other rivers would all be higher than that for the Tanana River crossing. Increasing the response time would, again, decrease the percentage of oil subject to recovery. For example, if the response time at Minton Creek increased from an average value of 4 hours to a worst-case value of 34 hours (Table 4.4-16), the percentage of oil subject to recovery would decrease to zero at the containment site. The magnitude of the change in the potential percentage of capture is much greater in this case because of the short pipeline emptying time used in the calculations (10 hours).

The results show that impacts from a likely spill event would be much more severe, and the area impacted could be larger, than discussed above for an anticipated spill event.

TABLE 4.4-16 Estimated Response Times for Various Spill Locations for a Likely Spill Scenario

Location	Nearest Milepost	Contingency Area	Duration of Leak due to Corrosion (h)		Duration of Leak due to Vandalism (h)		Estimated Response Time (h)		
			Large Hole	Small Hole	Large Hole	Small Hole	Worst Case	Average	Best Case
Dan Creek/ Sagavanirktok River	85	Sag River 2	10	102	11	105	34	4	3
Yukon River	353	Yukon	10	102	11	105	31	2	1
Minton Creek	510	Salcha	10	102	11	105	34	4	2
Tanana River	531	Big Delta	10	102	11	105	36	6	5
Gulkana River	654	Gulkana	10	102	11	105	32	3	2
Tazlina River	686	Tazlina	10	102	11	105	32	4	3

TABLE 4.4-17 Summary of Spill Results for a Worst-Case Likely Spill Scenario and a Small Hole

Location	Average Response Time (h)	High-Flow Velocity (mph)	Low-Flow Velocity (mph)	CS (mi)	Time to Reach CS for High Flow (h)	Time to Reach CS for Low Flow (h)	Spill Duration for a Small Hole (h)	Percentage of Spill Subject to Recovery at CS for High Flow	Percentage of Spill Subject to Recovery at CS for Low Flow
Dan Creek/ Sagavanirktok River	4	5.5	1.4	13.6	2.5	9.7	100	99	100
Yukon River	2	5.5	2.1	4	0.7	1.9	100	99	100
Minton Creek	4	2.7	0.7	12	4.4	17.1	100	100	100
Tanana River	6	6.8	2.1	4	0.6	1.9	100	95	96
Gulkana River	3	4.8	0.7	20	4.2	28.6	100	100	100
Tazlina River	4	6.8	1.4	5	0.7	3.6	100	97	100

TABLE 4.4-18 Summary of Spill Results for a Worst-Case Likely Spill Scenario and a Large Hole

Location	Average Response Time (h)	High-Flow Velocity (mph)	Low-Flow Velocity (mph)	CS (mi)	Time to Reach CS for High Flow (h)	Time to Reach CS for Low Flow (h)	Spill Duration for a Large Hole (h)	Percentage of Spill Subject to Recovery at CS for High Flow	Percentage of Spill Subject to Recovery at CS for Low Flow
Dan Creek/ Sagavanirktok River	4	5.5	1.4	13.6	2.5	9.7	10	85	100
Yukon River	2	5.5	2.1	4	0.7	1.9	10	87	99
Minton Creek	4	2.7	0.7	12	4.4	17.1	10	100	100
Tanana River	6	6.8	2.1	4	0.6	1.9	10	46	59
Gulkana River	3	4.8	0.7	20	4.2	28.6	10	100	100
Tazlina River	4	6.8	1.4	5	0.7	3.6	10	67	96

Unlikely Spill Events. Of the unlikely spill scenarios considered, a guillotine break in the pipeline caused by the impact of a fixed-wing aircraft would produce the largest oil release to inland waters (53,967 bbl, or 2,267,000 gal for a throughput of 1.1 million bbl/d). Because a guillotine break would release the largest quantity of oil, it is used as representative and bounding for the spill scenarios in the unlikely category.

For conservative results, the guillotine break for Scenario 21 was assumed to discharge oil directly into flowing water at the six elevated river crossings. Impacts from guillotine breaks in elevated pipeline segments over land could also impact nearby surface water resources, but the impacts to surface water would be less because some of the oil would remain on and in the ground while traveling from the location of the break to the water. Table 4.4-11 lists the volumes of oil that would be released following a guillotine break at major and minor elevated river crossings along the TAPS ROW. The volume would depend both on the location and the throughput of the pipeline. For the three throughputs considered in this DEIS (0.3 million, 1.1 million, and 2.1 million bbl/d), the greatest release of crude oil along the TAPS ROW for a guillotine break would occur at Minton Creek (MP 510). These release volumes would be 52,390 bbl (2,200,000 gal), 53,967 bbl (2,267,000 gal), and 50,561 bbl (2,250,000 gal) for throughputs of 0.3 million, 1.1 million, and 2.1 million bbl/d, respectively.

Table 4.4-19 summarizes spill volumes associated with a guillotine break at each of the six elevated crossings. These spills are all described as having a short duration. Because of the length of the pipeline between valves that would be closed in the event of a guillotine break to stop flow in the pipeline, a small amount of time would be needed to close the appropriate valves safely and discharge the oil in the affected pipe segment. Details on this calculation are provided in Folga et al. (2002). Estimates of these times required are provided in Table 4.4-19.

The largest predicted spill volumes and duration times for the guillotine break spill scenario would occur at Minton Creek. For a throughput of 0.3 million bbl/d, about 4.2 hours would be needed to close the appropriate valves and discharge the contents of the broken pipe section into the creek. The smallest release volumes and emptying times would occur at the Tanana River. The differences in release volumes is primarily a function of the location of valves in the pipeline relative to the location of the guillotine break.

While the spill event was in progress, oil discharged to the river would flow downstream at the velocity of the river current, forming a slick. For plug flow, the length of the slick can be estimated as the product of the velocity and the duration time of the spill. Because the flow of water in a river or stream is variable (e.g., the flow velocity in the Dan Creek/Sagavanirktok River varies from about 2 to 8 ft/s [Table 4.4-12]), the higher flow values in the flow ranges provide conservative estimates of the slick lengths given in Tables 4.4-20 and 4.4-21 for high- and low-flow conditions, respectively. The longest slick produced by a guillotine break during the discharge period would be 12.7 mi on the Dan Creek/Sagavanirktok River for a throughput of 0.3 million bbl/d. The shortest slick would be 0.9 mi on the Tanana River for a throughput of 2.1 million bbl/d. For each of the six rivers, the longest slicks would occur for the lowest throughput value (0.3 million bbl/d) because the drain time would be the longest for that throughput level.

Once a spill to water was detected, a spill response team would be sent to the containment sites identified in the contingency plans (Table 4.4-13) (APSC 2001), and recovery activities would begin. Under average conditions, the total response time would vary from 3 hours for the Yukon River crossing to 7 hours for the crossing on the Tanana River. By the time the response team reached any of the containment sites and initiated an appropriate response, the entire predicted volumes of oil would have been released to the rivers (Table 4.4-9), and the leading edge of the slick would have traveled downstream beyond the containment site for all rivers except the Gulkana. Assuming small losses during the initial phase of transport, the leading edge of the slick could be almost 50 mi downstream on the Tanana River before cleanup activities started (Table 4.4-14).

TABLE 4.4-19 Summary of Spill Volumes, Rates, and Drainage Times for River Crossings under Different Throughputs

Location	Milepost	Volume Released (bbl)	Initial Spill Rate (bbl/min)	Drainage Time (h)
0.3 million bbl/d Throughput				
Dan Creek/ Sagavanirktok River	85	28,998	208	2.3
Yukon River	353	20,477	208	1.7
Minton Creek	510	52,390	208	4.2
Tanana River	531	7,489	208	0.6
Gulkana River	654	26,308	208	2.1
Tazlina River	686	17,334	208	1.4
1.1 million bbl/d Throughput				
Dan Creek/ Sagavanirktok River	85	29,880	764	0.65
Yukon River	353	21,246	764	0.47
Minton Creek	510	53,967	764	1.18
Tanana River	531	8,486	764	0.19
Gulkana River	654	27,930	764	0.61
Tazlina River	686	18,291	764	0.40
2.1 million bbl/d Throughput				
Dan Creek/ Sagavanirktok River	85	31,662	1458	0.37
Yukon River	353	17,676	1458	0.22
Minton Creek	510	50,561	1458	0.58
Tanana River	531	11,612	1458	0.13
Gulkana River	654	24,690	1458	0.28
Tazlina River	686	15,871	1458	0.18

The percent of oil subject to recovery at the containment sites was estimated by using simple volumetric balances and plug-flow assumptions (Appendix A, Section A.15.2). These results are given in Table 4.4-20 for high flow conditions. For the Gulkana River, 100% of the slick would be subject to recovery activities consisting of use of diversion booms and berms (Table 4.4-12). (Booms would be used to divert the flow of oil toward one of the river banks, rather than trying to contain the oil directly because of the high-velocity current of the river). For the other river crossings, the tail of the slick would move past the containment point before the initiation of recovery operations if the oil moved downstream as plug flow. Recovery would be effective in the Gulkana River because the location of the front of the oil slick would not reach the containment site before the initiation of a recovery response; the Gulkana River has a small current (7 ft/s) relative to the other rivers, and its containment site is located farthest downstream of the break (20 mi). Although 100% of the oil would be subject to recovery on the Gulkana River, the downstream region between the pipeline break and containment site would be subject to major

TABLE 4.4-20 Summary of Spill Analyses for a Worst-Case Very Unlikely Guillotine Break during High-Flow Conditions for Three Pipeline Throughput Levels

Location	Milepost	Slick Length (mi) by Pipeline Throughput: 0.3×10^6 bbl/d	1.1×10^6 bbl/d	2.1×10^6 bbl/d	Location of Leading Edge of Slick at Average Response Time (mi)
Dan Creek/ Sagavanirktok River	85	12.7	3.7	2.0	27.5
Yukon River	353	9.0	2.6	1.2	16.5
Minton Creek	510	11.3	3.2	1.6	13.5
Tanana River	531	4.1	1.4	0.9	47.6
Gulkana River	654	10.1	3.0	1.3	19.2
Tazlina River	686	9.6	2.7	1.2	34.0

Location	Location of Trailing Edge, if Plug Flow (mi)			Distance to CS (mi)	Distance from Trailing Edge to Containment Site (mi)			Percent of Oil Subject to Capture		
	0.3×10^6 bbl/d	1.1×10^6 bbl/d	2.1×10^6 bbl/d		0.3×10^6 bbl/d	1.1×10^6 bbl/d	2.1×10^6 bbl/d	0.3×10^6 bbl/d	1.1×10^6 bbl/d	2.1×10^6 bbl/d
Dan Creek/ Sagavanirktok River	14.8	23.8	25.5	13.6 (CS2-0)	1.2	10.2	11.9	0	0	0
Yukon River	7.5	13.9	15.3	4.0 (CS5-29)	3.5	9.9	11.3	0	0	0
Minton Creek	2.2	10.3	11.9	12 (CS8-7A)	-9.8	-1.7	-0.1	87	87	6
Tanana River	43.5	46.2	46.7	4 (CS8-16)	39.5	42.2	42.7	0	0	0
Gulkana River	9.1	16.2	17.9	20 (CS10-16)	-10.9	-3.8	-2.1	100	100	100
Tazlina River	24.4	31.3	32.8	5 (CS10-20)	19.4	26.3	27.8	0	0	0

TABLE 4.4-21 Summary of Spill Analyses for a Worst-Case Very Unlikely Guillotine Break during Low-Flow Conditions for Three Pipeline Throughput Levels

		Slick Length (mi) by Pipeline Throughput			
Location	Milepost	0.3×10^6 bbl/d	1.1×10^6 bbl/d	2.1×10^6 bbl/d	Location of Leading Edge of Slick at Average Response Time (mi)
Dan Creek/ Sagavanirktok River	85	3.2	0.9	0.5	7.0
Yukon River	353	3.6	1.0	0.5	6.3
Minton Creek	510	2.9	0.8	0.4	3.4
Tanana River	531	1.3	0.4	0.3	14.7
Gulkana River	654	1.5	0.4	0.2	2.8
Tazlina River	686	2.0	0.6	0.3	7.0

	Location of Trailing Edge, if Plug Flow (mi)				Distance from Trailing Edge to Containment Site (mi)			Percent of Oil Subject to Capture		
Location	0.3×10^6 bbl/d	1.1×10^6 bbl/d	2.1×10^6 bbl/d	Distance to CS (mi)	0.3×10^6 bbl/d	1.1×10^6 bbl/d	2.1×10^6 bbl/d	0.3×10^6 bbl/d	1.1×10^6 bbl/d	2.1×10^6 bbl/d
Dan Creek/ Sagavanirktok River	3.8	6.1	6.5	13.6 (CS2-0)	-9.8	-7.5	-7.1	100	100	100
Yukon River	2.7	5.3	5.8	4.0 (CS5-29)	-1.3	1.3	1.8	36	0	0
Minton Creek	0.6	2.7	3.1	12 (CS8-7A)	-11.4	-9.3	-8.9	100	100	100
Tanana River	13.4	14.3	14.4	4 (CS8-16)	9.4	10.3	10.4	0	0	0
Gulkana River	1.3	2.4	2.6	20 (CS10-16)	-18.7	-17.6	-17.4	100	100	100
Tazlina River	5.0	6.4	6.7	5 (CS10-20)	0	1.4	1.7	0	0	0

impacts from oil coating (approximately 20 mi of shoreline, part of which is along a wild river corridor).

For the Minton Creek elevated river crossing, approximately 87% of the initial oil slick would be subject to capture for a throughput of 0.3 million bbl/d. Lesser quantities would be subject to capture at higher throughputs because of shorter drain times. Once the slick had moved beyond the containment site, it could continue to move downstream, contaminating additional portions of the river channel.

Because of spreading, the slick would get wider as it moved downstream. If the slick spread circularly (Yapa and Shen 1994), the slicks downstream of all of the elevated river crossings evaluated would be sufficiently wide to extend from bank-to-bank, even under conditions of high flows (Appendix A, Section A.15.2).

The above analyses assumed that the spilled crude oil would move downstream as a plug of crude oil with sharp leading and trailing edges and would not be in any way impeded. However, because of mixing, emulsification, entrainment, deposition, channel variations, rapids, encounters with boulders, islands, braiding, weather, and other factors, the oil slick would not move downstream as plug flow. Nonetheless, it is clear that for all rivers except the Gulkana, oil could be downstream of the containment sites before cleanup was initiated.

Impacts to the rivers and creek under high-flow conditions for the postulated guillotine break scenario would be major, and subsequent cleanup could take considerable time and effort because it is unlikely that the response teams could capture a significant portion of the spilled oil. Many miles of shoreline, as well as the bottom of the channel, could be affected. Because of the remoteness of the rivers and lack of easy access, these cleanup activities could be very difficult to accomplish.

Table 4.4-21 shows the results of similar calculations performed for low-flow conditions at the same elevated river crossings. For these conditions, 100% of the slicks would be subject to recovery for spills at the Dan Creek/ Sagavanirktok River, Minton Creek, and Gulkana elevated crossings. No capture would be predicted for elevated guillotine breaks and pure plug flow at river crossings on the Tanana and Tazlina Rivers. For the Yukon River crossing, 36% of the released oil would be subject to capture. As in the case of high flows, factors such as mixing, emulsification, entrainment, deposition, channel variations, rapids, encounters with boulders, islands, braiding, and weather would prevent the oil from being transported as a plug. However, a substantial portion of the initial release could be downstream of the containment sites before cleanup was initiated for at least two of the river crossings evaluated (Tanana and Tazlina Rivers).

Very Unlikely Spill Events. Of the very unlikely spill scenarios, a guillotine break of the pipeline at an elevated river crossing resulting from a helicopter crash would produce the largest oil release (53,967 bbl, or 2,267,000 gallons) to inland waters for a throughput of 1.1 million bbl/d. Because a guillotine break would release the largest quantity of oil, it was used as representative and bounding for the very unlikely spill scenarios.

For this spill scenario, release volumes for the six river crossings would be the same as those discussed above for the unlikely spill scenario for the guillotine break caused by a fixed-wing aircraft crash (Scenario 19a). Because the spill volumes and other parameters would be same as for those used to evaluate the unlikely spill scenario, the impacts associated with the guillotine break under this very unlikely spill scenario would be the same as those discussed above.

4.4.4.4 Groundwater Resources

4.4.4.4.1 Introduction. Groundwater resources along the TAPS ROW could be affected by spills, particularly if a spill occurred directly, or close, to underlying groundwater. This type of spill could occur along buried segments of the pipeline. Impacts to groundwater for the same spill occurring along aboveground pipeline segments would be, accordingly, smaller because oil would be lost on the land surface.

Four spill scenarios were analyzed for their effects on groundwater resources. Each is representative of one of the four spill-frequency categories. The first category consists of spills that are *anticipated*. Only one of these scenarios, (Scenario 1) would discharge oil below the ground surface. This spill would result from a small leak and would involve a maximum oil release of 50 bbl.

Impacts of Oil Spills on Groundwater

For anticipated spill events, the volume of oil spilled would be low (e.g., 50 bbl), and impacts to groundwater resources would be small and local. In the event of a very low probability accident involving a larger spill (e.g., an underground guillotine break of the pipeline that is initiated by a landslide and releases 46,000 bbl of crude oil), impacts to groundwater would range from small in magnitude and local in the Brooks and Alaska Ranges to very large in magnitude and extensive in the Chugach Range. Impacts of direct spills to groundwater could be minimized by proper planning, training, surveillance, and timely implementation of contingency plans.

The second category involves spills considered to be *likely*. Of the eight spill scenarios in this category, four could directly affect groundwater resources: Scenario 5 — a moderate, instantaneous leak of crude oil; Scenario 9 — a very short-duration leak caused by maintenance-related damage; Scenario 10 — a short-duration (10 hours) leak caused by overpressurization from inadvertent remote gate valve closure; and Scenario 14 — a prolonged (2 days) leak resulting from corrosion-related damage. Of these scenarios, Scenario 14 was evaluated because it would release the largest volume of oil (10,000 bbl) to the environment.

The third analysis was performed for spill scenarios that are considered to be *unlikely*. Of the five scenarios in this category, two could impact groundwater resources: a leak resulting from pipeline settling (Scenario 15); and a crack resulting from seismic fault displacement and ground waves (Scenario 16). Because of its larger release volume (16,000 bbl), Scenario 16 was analyzed.

The last analysis was performed for a *very unlikely* spill scenario. It consists of an underground guillotine break caused by a seismically induced landslide (Scenario 20). This spill would release a maximum of about 47,000 bbl of crude oil.

4.4.4.4.2 Impacts of Spill Scenarios.

Anticipated Spills. Scenario 1, an *anticipated* spill event (Section 4.4.1.1), would discharge oil below the ground surface from a small leak. The volume of oil released is assumed to be 50 bbl, and the release period is assumed to be instantaneous.

An underground release can only occur along buried sections of the pipeline. Three general regions have been identified along the TAPS ROW where an underground leak might occur: MP 140 to 255 in the Brooks Range, MP 560 to 610 in the Alaska Range, and MP 720 to 800 in the Chugach Range. Impacts are analyzed at MP 178 for the Brooks and Alaska Ranges, and at MP 741 for the Chugach Range. These locations were selected because they coincide with the locations of maximum oil releases for more severe, less frequent accidents discussed below.

Because the volume of oil released for the anticipated scenario would be very small (50 bbl), it is unlikely that any of the oil would emerge at the surface, although it would be released under pressure. Within the Brooks and Alaska Ranges, the 50 bbl of oil released would be in a region where permafrost is usually present. Because of the presence of permafrost, the oil would probably stay within the pipeline's gravel pack and affect the quality of water contained in thaw bulbs present at the location of the leak. Impacts would thus be small and local.

In the Chugach Range, permafrost is assumed to be absent at the location of the leak.

For this case, the released oil could migrate downward under the influence of gravity and contaminate the local groundwater system. Because of the small volume of oil released, impacts to the groundwater system would be small and local.

Likely Spills. For the *likely* category of spills, a prolonged leak resulting from corrosion-related damage was selected for analysis because it would release the greatest volume of oil (10,000 bbl over a 2-day period). Because this type of leak could occur anywhere along the ROW where the pipeline is buried, evaluations of the impacts to groundwater were made for the same locations as those selected for the anticipated spill scenarios — the Brooks and Alaska Ranges (represented by a spill at MP 178), and the Chugach Range (represented by a spill at MP 741).

For the Brooks and Alaska Ranges, the volume of oil released (10,000 bbl) would be much greater than that discussed for the anticipated spill scenario (50 bbl). Impacts to the groundwater system in the Brooks and Alaska Ranges would be small and local because of the presence of permafrost that would prevent oil from migrating to deep groundwater systems, if present.

In the Chugach Range, the volume of oil released would be much larger than that released for the anticipated spill scenario discussed above. Impacts would occur when the oil infiltrated the soil column and reached the underlying groundwater. The 2-day duration of the spill would allow some response activities to commence and limit the amount of oil available for infiltration. These impacts would, however, be potentially very large because of the volume of oil released.

Unlikely Spill Events. The third analysis was for a release of oil through a pipeline crack resulting from seismic fault displacements and ground waves (Scenario 16). This spill is considered to be *unlikely* (frequency of occurrence of once in 1,000 years to once in about 30 years). Because of its association with faulting, this spill scenario is assumed to occur at MP 590 in the area of the Denali Fault in the Alaska Range. It would release 16,000 bbl of oil over a short period (hours).

In the Alaska Range, permafrost is discontinuous. Because of the proximity of the Delta River to the pipeline in the vicinity of MP 590, permafrost is assumed to be absent. As with the spill scenarios analyzed above, crude oil released from a crack would be under pressure (about 1,180 psi). Because of the volume of oil released and the system pressure, it is probable that the released oil would rapidly migrate to the surface and contaminate the land. Even with losses to the land surface, the underlying groundwater system could experience severe water quality impacts because of the large volume of oil released.

Very Unlikely Spill Events. An instantaneous, underground guillotine break resulting from a landslide was analyzed for the *very unlikely* spill scenarios (Scenario 20). This type of event would be expected to occur only between once in 1 million years to once in 1,000 years. Three general regions have been identified along the pipeline where this event might occur: MP 140 to 255 in the Brooks Range, MP 560 to 610 in the Alaska Range, and MP 720 to 800 in the Chugach Range. These regions are all within mountain ranges where landslides are possible. However, a belowground guillotine break is only feasible in regions in which the pipeline is buried. These locations and their associated maximum release volumes are listed in Table 4.4-22. The predicted maximum volume of crude oil that would be released varies with both location and throughput. Table 4.4-23 summarizes the information for the three mountain ranges.

The largest volume of oil that would be released for the very unlikely spill scenario would be 46,994 bbl in the Brooks Range at MP 178 for a pipeline throughput of 2.1 million bbl/d. This location is near Atigun Pass (MP 166). This spill was used to establish an upper bound of impacts for other guillotine breaks with smaller release volumes in the Brooks and portions of the Alaska Ranges in which permafrost is present (permafrost is discontinuous in the Alaska Range).

TABLE 4.4-22 Belowground Segments of Pipeline in the Brooks, Alaska, and Chugach Ranges and Their Maximum Releases of Oil for a Guillotine Break

Location	Milepost Range (MP)	Belowground Segment Range (MP)	Location of Break for Maximum Oil Release (MP)	Maximum Release by Pipeline Throughput Level			Comments
				0.3×10^6 bbl/d	1.1×10^6 bbl/d	2.1×10^6 bbl/d	
Brooks Range	140–255	157–169	157	33,723	34,852	36,059	Along Atigun River, crosses Continental Divide, steep terrain
		171–175	171	26,671	29,976	32,819	Along Chandalar River, Chandalar Airstrip, steep terrain to the south
		177–178	178	41,061	44,271	46,994	Along headwaters of Dietrich River
		178–190	182	NA	NA	33,269	Along Dietrich River floodplain
			190	31,685	34,728	NA	
		191–196	196	32,533	35,489	31,304	Dietrich River floodplain
		205–206	205	37,028	39,858	36,296	Middle Fork Koyukuk River buried crossing
		211–212	211	30,080	32,826	29,469	Middle Fork Koyukuk River buried crossing
		215–216	216	27,120	29,797	26,647	Gold Creek buried crossing
		231–236	231	34,852	37,320	34,401	Floodplain Koyukuk River
		243–245	243	28,345	30,645	27,790	Floodplain Koyukuk River
Alaska Range	560–610	568–569	568	33,166	34,081	35,328	Unnamed buried stream crossing
		572–589	582	27,942	29,035	NA	Delta River floodplain, steep areas near MP 585 - Flood Creek and Michael Creek
			585	NA	NA	21,876	

TABLE 4.4-22 (Cont.)

Location	Milepost Range (MP)	Belowground Segment Range (MP)	Location of Break for Maximum Oil Release (MP)	Maximum Release by Pipeline Throughput Level			Comments
				0.3×10^6 bbl/d	1.1×10^6 bbl/d	2.1×10^6 bbl/d	
		590–593	593	24,139	25,385	26,328	Delta River floodplain
		599–602	599	28,300	29,575	30,329	Phelan Creek, some steep slopes
		603–610	603	18,502	19,834	20,661	Isabel Pass, Summit Lake
Chugach Range	720–800	720–721	720	13,870	14,352	12,687	Nearby steep slopes to the south
		724–725	724	12,080	12,506	10,591	Tonsina River buried river crossing
		730–735	730	32,110	20,950	19,010	Floodplain Little Tonsina River
		736–800	741	38,773	36,415	37,585	Many steep slopes

TABLE 4.4-23 Maximum Release Volumes and Locations for a Belowground Guillotine Break Caused by a Landslide

Location	Milepost Marker Range (MP)	Location of Maximum Release (MP)	Maximum Release by Pipeline Throughput Level		
			0.3×10^6 bbl/d	1.1×10^6 bbl/d	2.1×10^6 bbl/d
Brooks Range	140–237	178	41,061	44,271	46,994
Alaska Range	560–610	568	33,166	34,081	35,328
Chugach Range	720–800	741	38,773	36,415	37,585

A separate evaluation was performed for a belowground guillotine break in the Chugach Range at MP 741. This location maximizes the volume of oil that would be released (38,773 bbl for a pipeline throughput of 0.3 million bbl/d) between MP 720 and 800. This second evaluation was performed because of physical differences in the landforms present. In the Brooks and Alaska Ranges, permafrost is continuous and stable (Brooks Range), or discontinuous (Alaska Range). In the Chugach Range, permafrost is either sporadic or absent (TAPS Owners 2001a). The presence or absence of permafrost can affect the vertical migration of spilled oil toward underlying groundwater resources.

The first evaluation is for a guillotine break of the belowground segment of the pipeline at MP 178. On the south side of Atigun Pass (MP 166), the pipeline descends steeply and loses 1,200 ft in elevation at the head of the Chandalar River basin and then loses another 700 ft to the headwaters of the Dietrich-Koyukuk River system (approximately MP 185) (TAPS Owners 2001a). The upper Dietrich River valley is narrow with a steep gradient (change in elevation with distance); steep, intersecting fans occur on its side slopes. Permafrost is continuous in this region and is relatively cold (-3 to -7°C). During the winter, the active layer (a thin, seasonally thawed layer that lies on top of the permafrost) freezes to the top of the permafrost, which is located about 1.5 ft below the ground surface. Bedrock is near the surface.

A guillotine break of the buried pipeline at MP 178 would discharge oil to the trench and gravel pack around the pipeline and to any thaw bulbs that might have developed because of the presence of warm oil flowing through the pipe. Contact with any deeper groundwater, if present, beneath the permafrost would not occur because the permafrost is very thick and would prevent vertical migration of the oil. In addition, deep groundwater may not be present in this location because of the presence of near-surface rock.

Oil from the guillotine break would flow in the gravel pack of the trench downhill toward the Dietrich River floodplain. Because the oil is much warmer than the surrounding permafrost (oil temperature at PS 1 is about 116°F, at PS 6 it is about 66°F, and at the Valdez Marine Terminal the temperature of the crude is about 63°F [APSC 2001i]), some of the permafrost would melt, and the oil would move downhill in the pipeline trench. The energy required to melt the permafrost would come from the warm oil, thereby reducing the oil's temperature (Sears 1953). As the warm oil melted the permafrost, the viscosity of the oil would increase as its temperature dropped. This increase in viscosity would decrease the mobility of the oil. However, the presence of drag reducing agent in the pipeline could help maintain the fluidity of the oil.

During construction, the underground segments of the pipeline were buried in a trench that is about 8 ft wide and of variable depth. The depth of the trench was sufficient to bury the pipeline on top of a gravel pad and to accommodate at least 4 ft of overburden. The thickness of the overburden above the pipeline is variable (APSC 2001i). The normal thickness is about 4 ft. However, there are some areas of deep burial (e.g., Wilbur Creek, where the overburden thickness approaches 40 ft). The thickness of the overburden ranges between 4 and 20 ft in most areas (Norton 2002d). This overburden thickness exceeds requirements of the Department of Transportation (DOT 195.248) and the American Society of Mechanical Engineers (ASME 434.4) for pipelines.

At MP 178, the buried pipeline and trench are shallow because of the presence of stable permafrost and shallow bedrock. Although the physical size of the trench is small, a thaw bulb with a radius of 30 ft is assumed to have formed because of the flow of warm oil through the frozen soil (Appendix A, Section A.15.2). If a guillotine break occurred in this environment, pressurized oil would be released to the thaw bulb. Because the pressure in the pipeline exceeds 1,000 psi (APSC 2001i), it is likely that the released oil would emerge from below the ground and spill onto the land surface. Such belowground spills would have less impact than a direct spill onto the surface because of oil losses to the subsurface.

If the spilled oil remained underground in the thaw bulb along the pipeline, it would initially occupy a length of about 300 ft on the basis of mass conservation (Appendix A, Section A.15.2). Once the oil was in the trench and thaw bulb, it would continue to move downhill until the elevation increased sufficiently to reduce the velocity to zero, the oil found a path to the surface, or response activities stopped the oil from flowing farther. For these conditions, impacts to groundwater resources would be small and local.

In addition to contaminating the water in thaw bulbs along the TAPS ROW, oil released from an underground guillotine break could melt some of the surrounding permafrost. This melting would occur because the crude oil in the pipeline is warmer than the ice. For a spill volume of 46,994 bbl of oil at an initial temperature of 110°F, about 65,000 ft^3 of ice could be melted (Appendix A, Section A.15.2). If the initial radius of the thaw bulb was 30 ft, the impact of melting the surrounding permafrost would be to increase its radius by 1 ft over its calculated length of 300 ft. This impact would be negligible.

For the Chugach Range, the maximum release of oil from a belowground guillotine break would occur at MP 741. The maximum volume (38,773 bbl) would be released for a pipeline throughput of 0.3 million bbl/d (Table 4.4-23). At this location, the buried pipeline is in a region with either sporadic or no permafrost; this evaluation assumes that no permafrost is present. This assumption is also appropriate for areas of the Alaska Range in which permafrost is absent and the groundwater is shallow.

As before, the buried trench is assumed to have a width of 8 ft. However, the depth of the trench is assumed to be 12 ft, consistent with burial in a region with a thicker surficial soil. The flow of oil after the release is assumed to be primarily through the more permeable gravel pack of the trench, although vertical infiltration through underlying soil could also occur. The effective flow area of the fill material with a porosity of 0.3 is calculated to be about 15 ft^2 (Appendix A, Section A.15.2). For a spill volume of 38,773 bbl, the oil could fill the gravel pack for a distance of about 2.5 mi if there were no vertical infiltration (Appendix A, Section A.15.2) or pathway to the surface. The actual length of trench containing oil would depend on the depth of the pipeline, impediments to flow (e.g., interaction with valve structures, contact with surface water, etc.), properties of the fill material, properties of the crude oil and drag reducing agent, and properties of the surrounding soils and rock. If the material below the pipeline was alluvial fan deposits and glacial till, the oil could readily move down toward the water table. Because of the presence of numerous streams in this area, the water table could be shallow, and the oil could contaminate this groundwater resource. Impacts to the quality of the groundwater system could be potentially very large.

4.4.4.5 Physical Marine Environment

As discussed in Section 4.4.1, 12 scenarios for spills at the Valdez Marine Terminal were developed for analysis in this DEIS. The spill scenarios were developed on the basis of statistical data on potential spill-event-initiating activities; data or guidance from the DOT, DOE, and FAA; and assumptions about the continued operation and maintenance of the TAPS from 2004 through 2034. Section 4.4.1.1 and Table 4.4-2 describe each spill scenario, the types of chemicals spilled, the total amount released, the amount of the spill that would stay on the land, and the amount that would reach the physical marine environment. Nine of the 12 spills that could occur at the Valdez Marine Terminal could reach the waters of Port Valdez; these are represented by Scenarios 1, 2, 3, 4, 5, 6, 8, 9, and 11.

The spills that would reach Port Valdez waters can be divided into four groups according to the volume of contaminant that reaches the marine environment. The first group of spills would have volumes of less than 1 bbl. These are represented by Scenarios 1, 2, and 4, with volumes of 0.5, 0.02, and 0.7 bbl, respectively. Scenarios 2 and 4 involve diesel fuel, and Scenario 1 involves crude oil. The second group of crude oil spills would have volumes ranging from 80 to 500 bbl. These are represented by Scenarios 5, 6, and 8, with spill volumes of 500, 80, and 100 bbl, respectively. The third group is represented by Scenarios 3 and 9, in which the crude oil spill volumes reaching the physical marine environment would be 1,900 and 1,700 bbl, respectively. The fourth group is represented by Scenario 11, with a crude oil spill volume of 143,450 bbl reaching the water.

The spill scenarios can also be grouped by expected frequency into the four categories shown in Table 4.4-2. The first category is the *anticipated* spill scenarios, with occurrence frequencies of 0.5/yr or more. Scenarios 1 and 2 are in this group, with volumes of 0.5 and 0.02 bbl, respectively. The second category is the *likely* spill scenarios, which occur from 0.03 up to 0.5/yr. Scenarios 5, 3, and 4 are in this group, with volumes of 500, 1,700, and 0.7 bbl, respectively. The third category is the *unlikely* spill scenarios, which occur from 10^{-3} (0.001) up to 0.03/yr. Only Scenario 6, with an expected release of 80 bbl, falls into this category. The fourth and last category is *very unlikely* spill scenarios, which occur from 10^{-6} (0.000001) up to 10^{-3}/yr. Scenarios 8, 9, and 11 have expected occurrence frequencies in this range, with volumes of 100, 1,900, and 143,450 bbl, respectively.

4.4.4.5.1 Spill Locations. In the majority of the spill scenarios for the Valdez Marine Terminal, the initial release would be on land, and the spilled North Slope crude oil would flow over land until it reached the waters of Port Valdez. (Two diesel fuel spills and two crude oil spills would release contaminants directly into the water.) The volume of the initial releases would be significantly larger than the volume of the spill that would reach the water. All these overland spills would occur in, or near, the storage tank area or in the western portion of the Valdez Marine Terminal. The topography of this area is such that all these spills would flow into Unnamed Valdez Marine Terminal Creek and down to the waters of Port Valdez. Unnamed Valdez Marine Terminal Creek discharges into Port Valdez near Berth 4 and the small boat harbor, and it is the drainage for nearly all of the Valdez Marine Terminal area. The discharge location for Unnamed Valdez Marine Terminal Creek is shown on Figure 3.9-1. It is assumed that the discharge point for Unnamed Valdez Marine Terminal Creek is the release point for all of the spills that begin with a land release that are evaluated in this section.

Nine Scenarios of Oil Spills that Could Reach Port Valdez

In four scenarios, contaminants would be released directly into water; two would involve release of crude oil, and two would involve a release of diesel fuel.

In five scenarios, the initial release of crude would be on land, then the oil would flow over land to the waters of Port Valdez.

The release point for all spills would be near Berth 4 and the mouth of the unnamed Valdez Marine Terminal creek.

The four scenarios that represent the release of contaminants directly into the water — crude oil spill Scenarios 5 and 6 and diesel fuel spill Scenarios 2 and 4 — would occur during the loading of a tanker vessel. All these scenarios would have release points within the boomed area that is created around berthed tankers during loading and ballast water unloading procedures. These release points would most likely be at Berths 4 or 5. However, Berths 1 and

3 could potentially be used to load tankers and could also be a discharge point for a spill. The use of Berth 1 would be unlikely. Berths 3, 4, and 5 are relatively near the discharge point of Unnamed Valdez Marine Terminal Creek. It is assumed that all the Valdez Marine Terminal spill scenarios that could potentially affect physical marine resources would have release points in essentially the same area, which is the discharge point of Unnamed Valdez Marine Terminal Creek, shown on Figure 3.9-1.

4.4.4.5.2 Spill Model. The movement and spread of oil in the waters of Port Valdez were evaluated by using the General NOAA Oil Modeling Environment (GNOME) model developed by the Hazardous Materials Response Division of the NOAA, Office of Response and Restoration (NOAA 2000). GNOME is publicly available. It is an oil spill trajectory model that simulates oil movement in marine environments due to winds, currents, tides, and spreading. GNOME predicts how winds, currents, and other processes might move oil spilled on the water and spread it. It uses site-specific data, such as data on local currents and bathometry, in addition to other local data. In addition to providing best estimates of oil movement on the basis of these local parameters, GNOME also predicts how oil trajectories might be affected by inexactness (“uncertainty”) in observations and forecasts of winds and currents. GNOME also models the physical and chemical changes to oil (weathering) that can occur while the oil remains on the ocean surface (NOAA 2000).

The GNOME model uses a method to incorporate uncertainty called the “minimum regret” approach (Galt et al. 1996). This source notes that trajectory models cannot be considered deterministic because of the uncertainties associated with the various data they require, the sensitivity of model parameters, and various model assumptions. It states, “The minimum-regret strategy can identify less likely, but extremely dangerous or expensive, scenarios that may require the development of alternate protection strategies” (Galt et al. 1996). A minimum-regret strategy tries to minimize the consequences of various response actions by identifying sensitive areas that might be less likely to be impacted by a spill and by ensuring that these areas are also protected, even though best estimates of spill trajectories might indicate that these areas would not be impacted.

To implement the minimum-regret approach, a modeling method called “trajectory analysis” (rather than trajectory modeling) is used (NOAA 1996). Trajectory analysis essentially requires evaluating uncertainty in various parameters, especially wind and weather, and treating the model as a trajectory model that generates estimates of potential oil spill movement rather than as a deterministic model that generates a best estimate of actual oil spill movement.

4.4.4.5.3 Properties of North Slope Crude Oil. Oils are generally classified into five groups for purposes of spill contingency planning (Michel et al. 1994). North Slope crude is classified as a Group III oil, which is termed “medium oils and intermediate products.” Some examples of Group III oils are North Slope crude, South Louisiana crude, intermediate fuel oils, and lube oils. Group III oils have the following properties (Michel et al. 1994):

- They are moderately volatile (flash point higher than 125°F/52°C).
- Up to one-third of the oil will evaporate.
- They have moderate to high viscosity.
- Their specific gravity is 0.85 to 0.95; their API gravity is 17.5 to 35.
- Their acute toxicity is variable, depending on the amount of light fraction.
- They can form stable emulsions.

North Slope Crude Oil

North Slope crude oil is a Group III oil. It tends to emulsify quickly, and 15-20% evaporates within 24 hours of a spill. The rest forms a stable mousse containing up to 75% water. Its viscosity increases, and sticky streaks, patches, and balls result, making cleanup difficult. Recovery from the water and shoreline is most effective early in a spill response.

- They will coat and penetrate the substrate; heavy subsurface contamination is likely.
- Stranded oil tends to smother organisms.
- Recovery from the water and shoreline cleanup are most effective early in the response.

Crude oil is a mixture of various hydrocarbons that can vary greatly in chemical composition (NOAA 2002a). The variations depend on the crude's geographical origin and any chemicals, such as surfactants, that might be mixed with the oil to aid production or transport. These additives can also affect the way a crude oil behaves when it is spilled (NOAA 2002a).

In addition to the general features that describe Group III oils presented above, NOAA (2002a) provides a list of important features for a marine spill that are specific to North Slope crude blends. These descriptions of features are adapted from NOAA (2002a).

- North Slope crude blends tend to emulsify quickly, forming a stable emulsion (or mousse). The rate of emulsification is known to be accelerated by wind mixing and is thought to be related to the blend's wax content. North Slope crude is thought to form a mousse after about 14% of the lighter components evaporate.
- From 15 to 20% of North Slope crude evaporates in the first 24 hours of a spill, depending on the wind and sea conditions. Very little oil is dispersed into the water column during this time. After 24 hours, the weathered oil then starts to form a stable mousse with up to 75% water content. This process can increase the oil-slick volume up to four times. During this change, the physical characteristics of the North Slope crude change dramatically.
- The viscosity of the oil-in-water mixture increases rapidly, and the color usually turns from dark brown and black to lighter browns and rust. As the water content of the emulsion increases, weathering processes (e.g., dissolution and evaporation) slow down.
- The "sticky" mousse behaves differently from a fluid and may react to additional weathering forces by forming a surface skin, creating a nonhomogenous material with a crust of slightly more weathered mousse surrounding a less weathered core.
- As the mousse is subjected to increased mixing from energetic wave action, the crusts can be torn or ruptured, and the less weathered mousse can be released. The continued exposure of weathered mousse to wave action continues to stretch and tear patches of mousse into smaller bits, resulting in a field of streaks, streamers, small patches, and, eventually, small tarballs.
- The oil-in-water emulsion is very sticky and makes cleanup and removal more difficult. When the emulsion is stranded on the shoreline, the degree of adhesion varies, depending on the substrate type. For example, this mousse will not penetrate far in finer sediments.

4.4.4.5.4 Spill Impacts

Anticipated Spills. The *anticipated* spill category includes Scenario 1, a 0.5-bbl leak of crude oil directly into the waters of Port Valdez, and Scenario 2, a 0.02-bbl leak of diesel fuel directly into the waters of Port Valdez. These spills would occur close to the shoreline, and it is assumed that they would have a short duration (Table 4.4-2). Impacts to the water column would be minimal because the volume of oil or diesel fuel released to the harbor would be small. Impacts near the shore could be significant, but they would be relatively short-lived. The nearshore environment could be impacted for

Impact of Anticipated Spills on the Physical Marine Environment

These spills would occur during operation and probably be noticed quickly, resulting in a short response time. Impacts would be confined to the nearshore environment near the loading berths.

several tens to hundreds of feet, but all significant impacts would be relatively close to the release point. Because of the small volume of these spills, cleanup and mitigation measures would be able to minimize the magnitude and spatial extent of the impacts. These spills would occur during operations at the Valdez Marine Terminal. Frequent observation of areas near the shore that might be impacted by these types of spills could result in shorter response and containment times, minimizing any impacts from the spills.

Likely Spills. The *likely* spill category includes Scenario 5, a crack in a tanker vessel during loading; Scenario 3, a moderate leak of crude during Valdez Marine Terminal operations; and Scenario 4, a moderate leak of diesel fuel during Valdez Marine Terminal operations. Spill volumes reaching the waters of Port Valdez would be 500, 1,700, and 0.7 bbl, respectively.

Impact of Likely Spills on the Physical Marine Environment

Scenario 5 involves a release during tanker loading that would be contained by booms placed around the ship to present significant quantities of oil from reaching the shore.

Potential impacts from Scenario 4, the 0.7-bbl leak of diesel fuel, would be similar to the impacts from the *anticipated* spill category discussed above.

Scenario 5 would involve the introduction of significant volumes of North Slope crude oil (500 bbl) into the waters of Port Valdez. The leak would occur during tanker loading, and the crude oil released to the port waters would be contained by the booms that are placed around tankers before loading begins. This containment would minimize the area impacted by the spill and prevent significant quantities of oil from reaching the shore. As noted above, in the first 24 hours, North Slope crude does not significantly dissolve in the water column, and any oil that does dissolve is diluted quickly. Impacts from Scenario 5 would be short lived, on the order of a few days to a few weeks. Mitigation would involve following required operating procedures, such as boom deployment, during tanker loading and quickly responding to any spills.

Scenario 3 would involve the release of 1,700 bbl of crude oil into Port Valdez. Since this spill would result from Valdez Marine Terminal operations, it is assumed that it would be released to Port Valdez waters at the mouth of Unnamed Valdez Marine Terminal Creek. This release scenario is almost the same as Scenario 9 in the *very unlikely* category. Impacts from these spills were estimated by the GNOME model (NOAA 2000) and are discussed in detail in the *very unlikely spill* section below.

Unlikely Spills. The *unlikely* spill category only contains one spill, Scenario 6, which would involve a failure of the loading system between the dock and the ship, resulting in the release of 80 bbl of North Slope crude into the waters of Port Valdez. This spill would occur during loading operations, after the tanker had been enclosed with a protective boom. The 80-bbl spill volume would be contained by these booms. As noted above, North Slope crude does not significantly dissolve in 24 hours. However, there would be some dissolution of the lighter crude fractions, which would be quickly diluted by tides and currents in the harbor. Impacts to the area within the boom would be short-lived. Mitigation would involve following required operating procedures, such as boom deployment, during tanker loading and quickly responding to and cleaning up any spills.

Impact of Unlikely Spills on the Physical Marine Environment

An unlikely spill would occur within the booms placed around tankers during loading, which would minimize the area impacted.

Very Unlikely Spills. The *very unlikely* spill category includes three scenarios: Scenario 8, a pipeline failure between the east tank farm and the west manifold, resulting in 100 bbl of North Slope crude reaching the waters of Port Valdez; Scenario 9, a pipeline failure between West Metering and Berth 5, resulting in

1,900 bbl of North Slope crude reaching the waters of Port Valdez; and Scenario 11, the catastrophic rupture of a crude oil storage tank, resulting in 143,450 bbl of North Slope crude reaching the waters of Port Valdez. In addition, since Scenario 3 is very similar to Scenario 9, it is evaluated in this section. These scenarios would all have release points into Port Valdez at the mount of Unnamed Valdez Marine Terminal Creek near Berth 4 and the small boat harbor.

Impact of Very Unlikely Spills on the Physical Marine Environment

For very unlikely spills, it is assumed that large volumes of crude oil would be released to the waters of Port Valdez and would not be contained for 2 hours. During that time, the plumes could expand and impact up to 2 mi of shoreline. Impacts would be mostly restricted to that area.

The GNOME computer program was used to estimate the spread of oil from the mouth of Unnamed Valdez Marine Terminal Creek after a release. The GNOME program uses input data from location files for specific local conditions. These estimates used data in the Prince William Sound location file compiled by NOAA (2002b). These data include the effects of five current patterns to simulate the circulation and tides in Prince William Sound and Port Valdez. NOAA (2002b) states:

> "The tides at Hinchinbrook Strait, Port Wells, Montague Strait, and Valdez Arm are each simulated with separate current patterns. The tidal circulation of Latouche Passage, Elrington Passage and Prince of Wales Passage are all simulated with two current patterns: (1) a modified portion of the Montague Strait current pattern and (2) a background current pattern. The background current pattern models the net surface currents through each of these passages: Latouche Passage (-0.3 knots); Elrington Passage (0.3 knots); and Prince of Wales Passage (-0.9 knots). The tidal current pattern for Montague Strait was extended to each of these passages with relative amplitudes that approximate the residual tides. Since the phase differences between these areas were on the order of an hour, this approximation was considered acceptable."

The *very unlikely spill* scenarios assume that the North Slope crude oil would be released at the mouth of Unnamed Valdez Marine Terminal Creek and that it would spread for 2 hours before response and containment occurred. The actual response time could be very different because unforeseen circumstances could occur. For example, because all these hypothetical spills would initially occur on land and flow to Port Valdez, marine response actions could begin before the North Slope crude reached the port waters, resulting in significantly shorter response times than those assumed in the scenario. It is also assumed that these spills would occur under nonextreme weather conditions. However, there is a possibility that these spills could occur under extreme weather conditions, and the winds and currents could be different from those used in the model. These differences could result in a larger area being impacted by the potential oil spills.

Prevailing winds in Port Valdez are generally from the northeast at speeds up to 15 knots. The other prevalent wind direction in Port Valdez is from the southwest at about 12 knots (TAPS Owners 2001a). Both of these prevailing wind speeds were used in the model runs to estimate the impacts of the various spill scenarios. The results of these model runs are summarized in Table 4.4-24. As the table shows, the majority of the model runs used a wind from the southwest at a speed of 12 knots. While this wind direction is not as prevalent as that from the northeast, it would move the oil slick away from the shore, into Port Valdez. This difference can be seen in the estimates for Scenario 11a and 11b. The only difference between these scenarios is the wind direction and speed. Winds from the northeast result in more of the North Slope crude oil being beached, while winds from the southwest result in more oil floating in the water 2 hours after the release. For Scenarios 11a and 11b, the amount of North Slope crude that is still floating 2 hours after the release changes from 16% of the spill to 52% of the spill, respectively.

TABLE 4.4-24 GNOME Model Results for Spills to Port Valdez from the Valdez Marine Terminal[a]

Parameter	Spill Scenario 8	9	11a[b]	11b	11c
Volume of spill (bbl)	100	1,900	143,450	143,450	143,450
Release time	1:00 a.m.	1:00 a.m.	1:00 a.m.	1:00 a.m.	1:00 p.m.
Wind direction[c]/speed	SW/12 knots	SW/12 knots	NE/15 knots	SW/12 knots	SW/12 knots
Volume of oil floating (bbl)	16 (15.6%)	987 (51.5%)	23,526 (16.4%)	73,877 (51.5%)	75,455 (52.5%)
Volume of oil beached (bbl)	81 (81.2%)	861 (45.3%)	115,334 (80.4%)	64,983 (45.3%)	63,405 (44.2%)
Volume of oil evaporated/ dispersed (bbl)	3 (3.2%)	61 (3.2%)	4,590 (3.2%)	4,590 (3.2%)	4,590 (3.2%)

a Release date for all scenarios was arbitrarily selected as February 20, 2003, for these modeling purposes.

b Scenario 11 was evaluated for variations in wind and tide conditions and, therefore, is presented as Scenarios 11a, 11b, and 11c.

c SW = southwest, NE = northeast.

In addition to the effects of wind variability, the differences in currents at different times of the day were also evaluated. The model runs were all based on a release date of February 20, 2003 (this was arbitrarily chosen). Most runs used a release time of 1:00 a.m., when it was assumed the longer 2-hour response time was more likely. Scenarios 11b and 11c evaluated the impacts of different release times on the behavior of the spill. Scenario 11b had a release time of 1:00 a.m., while Scenario 11c had a release time of 1:00 p.m. Although there were some differences in the results for the different release times, those differences were not significant relative to the inherent model uncertainties.

For all the release scenarios modeled, the oil slick moved out from the shore and expanded radially. The generally direction of the movement depended on the wind direction. For wind directions from the southwest, the oil slick moved generally to the northeast, but more north than east because of the influence of the point of land where Berth 3 is located. When winds were modeled as coming from the northeast, the oil moved along the shoreline to the west of the Valdez Marine Terminal.

All the modeled releases for Scenarios 3, 9, and 11 predicted that the shoreline would be oiled from Berth 3 to Berth 5. The scenarios with winds from the northeast predicted that the shoreline would be oiled as far west as the mouth of Sawmill Creek, while the scenarios with winds from the southwest did not predict the oil would reach that far. These scenarios predicted that the shore would be oiled from about Berth 1 to Berth 5, with the oil moving in a more northeasterly direction. The model predicts that the oil slick could move up to 6 mi from the release point in a northeast direction and up to 1 mi in a northwest direction.

Scenario 11 would result in the greatest amount of oil being released, and up to 2 mi of shoreline would be significantly impacted during the 2 hours before the response. It is assumed that at the 2-hour point, the spill would be contained, and further spreading would be stopped. However, for Scenario 11, it is likely that some oil would escape the initial containment, and it could impact other areas in Port Valdez. Outside the containment area, these impacts would be small and localized. Within the containment area, the impacts would be significant. It is assumed that once the oil was contained, removal actions would begin. As noted above, North Slope crude does not significantly dissolve into the water column during the first 24 hours after a spill, but dissolution does take place. Dissolved constituents resulting from the spill could have minor local impacts, but dilution effects would limit the impacts away from the spill areas. As noted in Section 3.9.3 on marine environment, the waters of Port Valdez are well mixed, with a complete flushing occurring, conservatively, every few weeks (usually quicker). During winter storms, the waters can be completely flushed within a few days.

The model predicts that the areas immediately around the release point near the mouth of Unnamed Valdez Marine Terminal Creek would be significantly impacted from the release of 143,450 bbl of oil, as postulated under Scenario 11. Approximately 2 mi of shoreline would be heavily oiled, and the waters immediately around the area would also be impacted. If this release was contained within 2 hours, the impacts would be localized. Impacts to the waters of Port Valdez would likely be relatively short-lived, on the order of a few weeks, due to flushing. Impacts to the oiled shoreline would be expected to last significantly longer. The oil on the shoreline could also continue to impact the waters of Port Valdez in the immediate area, but because of dilution and the existing hydrocarbon background concentrations, these impacts would be minimal. The potential exists for impacts in other areas of Port Valdez; these impacts would likely be small and localized. As noted in Section 3.11.3, a significant background concentration of hydrocarbons already exists in Port Valdez waters.

Scenario 8 would be confined to the immediate vicinity of the release point near the mouth of Unnamed Valdez Marine Terminal Creek. Scenarios 9 and 3 would result in the shoreline from Berth 3 to Berth 5 being oiled, causing significant impacts in this area. Impacts from these scenarios to the waters of Port Valdez would be localized and short-lived, on the order of a few weeks at most. Impacts to the shoreline could last longer, as discussed above.

Mitigation for these postulated releases could include minimizing response time and minimizing the time required to contain a release. For all these land-based releases, if a marine response was initiated when a leak was first detected on land, the response times could be significantly shortened. The majority of land-based leaks at the Valdez Marine Terminal would have the same release point to the waters of Port Valdez: the mouth of Unnamed Valdez Marine Terminal Creek. The quick deployment of containment systems at this location could reduce the probability that a land-based spill would have a large impact on the physical marine environment.

4.4.4.6 Air Quality

This section describes the estimated potential air quality impacts in the vicinity of the TAPS ROW that could result from accidental releases or spills of crude oil and petroleum products, such as diesel fuel, under the proposed action. The topics of the discussion include:

- Spill scenarios selected for air quality impact assessments;
- Estimates of HAP emissions that would result from the evaporation of volatile components (e.g., benzene, toluene, and hydrogen sulfide [H_2S]) of spilled crude oil and petroleum products;
- Dispersion modeling; and
- Ambient concentrations that would result from these emissions at receptor locations of interest.

Spills of crude oil and petroleum products may or may not involve fire. This section evaluates potential air quality impacts due to spills not involving fire. Potential air quality impacts of spills involving fire are discussed in Section 4.4.3.

4.4.4.6.1 Spill Scenarios. Spill scenarios, their expected frequencies of occurrence, the materials being spilled, and estimated spill volumes, release points, and release durations are described in Section 4.4.1. Spill volumes were estimated for four categories of expected frequencies of occurrence (anticipated, likely, unlikely, and very unlikely) under three levels of pipeline crude oil throughput (0.3, 1.1, and 2.1 million bbl/d).

Assessments of potential air quality impacts due to spills were limited to their implication on public health impacts discussed in Section 4.4.4.7. Thus, the assessments of air quality impacts focused on spills near population centers: Fairbanks at MP 456 (land-based spills), Valdez Marine Terminal (land- and marine-based spills), and the Yukon River from MP 353 to 354 (river-based spills). Potential spills on roadways due to accidents involving tanker trucks carrying turbine fuel or arctic grade diesel fuel were also included in ambient air quality impact assessments. The maximum spill volumes estimated for crude oil and petroleum products at these locations for the four frequency categories are listed in Table 4.4-25.

The potential maximum volumes of spills from the TAPS pipeline at MP 456 cover the following range: 100 bbl of diesel fuel for anticipated events (small leak during pipeline operations); 10,000 bbl of crude oil for likely events (moderate leak due to corrosion-related damage, sabotage, or vandalism); 42,101 bbl of crude oil for unlikely events (spill due to guillotine break resulting from a fixed-wing aircraft crash); and 42,101 bbl of crude oil for very unlikely events (spill due to guillotine break resulting from a helicopter crash) (see Tables 4.4-1 and 4.4-5).

The river-based spill site selected for evaluation of potential air quality impacts is the Yukon River from MP 353 to 354. The potential maximum volumes of spills from the pipeline at this location cover the following range: 50 bbl of crude oil for anticipated events (small leak during pipeline operations); 10,000 bbl of crude oil for likely events (moderate leak due to corrosion-related damage, sabotage, or vandalism); 21,246 bbl of crude oil for unlikely events (spill due to guillotine break resulting from a fixed-wing aircraft crash); and 21,246 bbl of crude oil for very unlikely events (spill from guillotine break resulting from a helicopter crash) (see Tables 4.4-1 and 4.4-5).

The potential maximum volumes of spills from Valdez Marine Terminal cover the following range: 15 bbl of diesel fuel for anticipated events (small leak of diesel fuel during Valdez Marine Terminal operations); 4,900 bbl of crude oil (3,200 bbl remain on land and 1,700 bbl drain to Port Valdez) for likely events (moderate leak of crude oil during Valdez Marine Terminal operations); 450 bbl of diesel fuel for unlikely events (due to diesel fuel line rupture); and 510,000 bbl of crude oil (about 316,000 bbl remain within the secondary containment, 50,350 bbl spread outside the secondary containment, and 143,450 bbl flow into Port Valdez) for very unlikely events (spill from the catastrophic failure of a storage tank, such as a foundation or weld failure) (see Table 4.4-2).

The potential maximum roadway accident-related spills are estimated to be 190 bbl of turbine or diesel fuel for likely to very unlikely events (overturn of a tanker truck carrying the fuel at various roadway locations) (see Table 4.4-3).

4.4.4.6.2 Estimation of Emissions. Emissions of 11 HAPs from evaporation of crude spilled oil and petroleum products were estimated: benzene, cyclohexane, ethyl benzene, n-heptane, hexane, naphthalene, n-octane, styrene, toluene, xylene, and hydrogen sulfide. The vapor pressures and weight percent (wt%) of these HAPs in North Slope crude oil, turbine fuel, and arctic grade diesel fuel are listed in Table 4.4-26.

The emission rate of a HAP from a spill area is a function of the temperature and surface area of the spill, molecular weight and partial pressure of individual HAP species, wind speed, and the time elapsed since the spill (IT Alaska 2001). The surface area and thickness of a pool formed by a land-based spill would depend on many factors, such as the degree and variability of slope, surface roughness, and porosity of the receiving land. After the initial formation of the pool, the surface layer of the pool would be subjected to weathering that would alter the composition of spilled oil. To estimate ambient

TABLE 4.4-25 Spill Scenarios without Fire, Frequencies, Spill Volumes, and Receiving Media at Selected Spill Locations

Spill Location	Frequency Range[a]	Spilled Material	Receiving Medium	Max. Spill Vol. (bbl)	Spill Area (acres)[b]	Release Duration	Spill Scenario
Fairbanks (MP 456)	Anticipated	Diesel fuel	Land	100	0.16	Instantaneous	Small leak during pipeline or pump station operation (Scenario 2)[c]
	Likely	Crude oil	Land	10,000	15	Prolonged (days)	Leak due to corrosion, sabotage, or vandalism (Scenarios 12, 14)[c]
	Unlikely	Crude oil	Land	42,101	65	Short (hours)	Guillotine break due to aircraft crash or landslide (Scenarios 19a, 20)[c,d]
	Very unlikely	Crude oil	Land	42,101	65	Short (hours)	Guillotine break due to impact of a helicopter (Scenario 21)[c,d]
Yukon River (MP 353–354)	Anticipated	Crude oil	River	50	Variable[e]	Instantaneous	Small leak during pipeline operations (Scenario 2)[c]
	Likely	Crude oil	River	10,000	Variable[e]	Over 2 days	Leak due to corrosion, sabotage or vandalism (Scenarios 12, 14)[c]
	Unlikely	Crude oil	River	21,246	Variable[e]	Short	Guillotine break due to aircraft crash (Scenarios 19a, 20)[c,d]
	Very unlikely	Crude oil	River	21,246	Variable[e]	Short	Guillotine break due to impact of a helicopter (Scenario 21)[c,d]
Valdez Marine Terminal	Anticipated	Diesel fuel	Land	15	0.02	Short	Small leak during Valdez Marine Terminal operations (Scenario 2)[f]
			Marine	0.02	1×10^{-5}		
	Likely	Crude oil	Land	3,200	5	Short	Moderate leak during Valdez Marine Terminal operations (Scenario 3)[f]
			Marine	1,700	1		
	Unlikely	Diesel fuel	Land	450	0.7	Short	Fuel line rupture (Scenario 7)[f]
			Marine	0	0		
	Very unlikely	Crude oil	Land	316,000[g]	10	Instantaneous	Catastrophic rupture of storage tank (Scenario 11)[f]
				50,350	15		
			Marine	143,340	86		

TABLE 4.4-25 (Cont.)

Spill Location	Frequency Range[a]	Spilled Material	Receiving Medium	Max. Spill Vol. (bbl)	Spill Area (acres)[b]	Release Duration	Spill Scenario
Roadway	Unlikely	Turbine fuel	Land	190	0.3	Instantaneous	Overturn of fuel truck (Scenarios 3 and 4)[h]
	Very unlikely	Turbine/ diesel fuel	Land	190	0.3	Instantaneous	Overturn of fuel truck (Scenarios 1, 2, 5, 6, 7)[h]

a Anticipated (> 0.5/yr); likely (0.03–0.5/yr); unlikely (10^{-3}–0.03/yr); very unlikely (10^{-6}–10^{-3}/yr).

b Based on 1-in.-thick spills on land. Thickness of the plug flow of oil spilled into rivers is estimated on the basis of channel width, current speed, and the rate of oil release for the Valdez Marine Terminal. Thicknesses of oil in the containment area and in a marine environment are assumed to be 2.6 and 49.9 in., respectively.

c See Table 4.4-1.

d See Table 4.4-5.

e Spill area changes as a function of the rate of the spill release, the channel width, and the time elapsed since the start of the spill.

f See Table 4.4-2.

g Of the total volume (510,000 bbl) of a storage tank, about 316,000 bbl remain in the secondary containment, about 190,000 bbl escape secondary containment, and about 143,000 bbl reach Port Valdez.

h See Table 4.4-3.

TABLE 4.4-26 Vapor Pressures and Weight Percents of Hazardous Air Pollutants in North Slope Crude Oil, Turbine Fuel, and Arctic Grade Diesel Fuel

		Weight %		
HAP Species	Vapor Pressure (mm Hg)[a]	North Slope Crude Oil[b]	Turbine Fuel[c]	Arctic Grade Diesel Fuel[c]
Benzene	61.7	0.36	0.05	0.24
Cyclohexane	69.5	0.94	–[d]	–
Ethyl benzene	5.2	0.06[e]	–	0.09
n-Heptane	31	1.64	–	–
n-Hexane	103.4	0.94	–	–
Naphthalene	0.05	0.10[e]	–	0.34
n-Octane	10.3	1.90	–	–
Styrene	3.6	0.50[f]	–	–
Toluene	18.1	0.81	0.30	0.50
Xylene	5.2	0.50[f]	–	0.53
Hydrogen sulfide	11,893	0.006[g]	–	–

[a] At 60°F. Source: Yaws (1994).

[b] Roehner (2001).

[c] MAPCO (2002).

[d] A dash indicates that no data exist. When data for turbine fuel and arctic grade diesel oil were not available, data for North Slope crude oil were used in spill emission estimations.

[e] Riley et al. (1980).

[f] National Research Council (1985).

[g] OGJD (2000).

air quality impacts, three thicknesses (1, 2, and 3 in.) were assumed, and associated surface areas were calculated. Emission rates of HAPs from land-based spills were computed according to the procedures described in IT Alaska (2001) for wind speeds of 1.5 and 3 m/s.

Estimating the behavior and fate of crude oil and petroleum products spilled into running waters is quite complicated (see Section 4.4.4.3). Many factors can affect the size and speed of an oil slick produced from a spill, including the width of the river channel, speed of the surface current, and speed and direction of the surface wind. While flowing downstream, the oil slick can be affected by processes such as advection, mechanical spreading, emulsification, evaporation, dissolution, shoreline deposition, photochemical reactions, and biodegradation. To obtain rough estimates of potential air quality impacts, the oil slick was assumed to form instantaneously and travel at the speed of surface current as a plug flow (rectangular-shaped) defined by the channel width of the stream. The surface current speed of the Yukon River at the spill location was assumed to be

8 ft/s, and the channel width was assumed to be 2,750 ft. The size and the center position of the rectangular-shaped oil slick were determined on an hourly basis from the time of the spill, and the corresponding hourly emission rate of each HAP was computed for wind speeds of 1.5 and 3 m/s. Emission rates for selected spills during the first hour after the spill when the wind speed is 3 m/s are listed in Table 4.4-27.

4.4.4.6.3 Dispersion Modeling. Ambient concentrations of HAPs caused by evaporative emissions from spills were estimated at the locations of interest (e.g., residential areas) in the vicinity of spill sites by using the Industrial Source Complex (ISC-3) model or ALOHA model as appropriate. The ISC-3 model is recommended by the EPA for estimating ambient impacts of stationary point and area sources with hourly meteorological data input. It was used for estimating ambient impacts due to spills at Fairbanks (MP 456), Yukon River (MP 353–354) and the Valdez Marine Terminal. Typical meteorological conditions (neutral stability [D class] and 3-m/s wind speed) and worst-case meteorological conditions (stable stability [F class] and 1-m/s wind speed) were used as the input to the ISC-3 model. The ALOHA model is a screening model also recommended by the EPA for estimating short-term ambient impacts from accidental releases. This model was used for estimating ambient impacts from transportation-related accidents. Meteorological conditions conducive to maximum ambient concentrations (i.e., a very stable [Category F] atmospheric condition and 1.5-m/s wind speed were assumed).

Emissions of VOCs from a crude oil spill, including HAPs, are known to be negligible for approximately 24 h after an initial spill occurs (IT Alaska 2001). Therefore, air quality impacts due to emissions from spills were estimated in terms of short-term concentration (1-hour average concentration). The 1-hour average ambient concentrations of HAPs caused by these emissions were estimated at the downwind boundary of the spill area for the spills (in the direction parallel to the largest dimension of the spill area) at Fairbanks, Yukon River, and Valdez Marine Terminal.

4.4.4.6.4 Ambient Concentrations. The estimated maximum 1-hour average concentrations of various HAPs in the vicinity of spills that would result from the selected maximum spills with anticipated, likely, unlikely, and/or very unlikely frequencies of occurrence at Fairbanks (MP 456), Yukon River (MP 353–354), and Valdez Marine Terminal and on the roadway are listed in Tables 4.4-29 through 4.4-32. Potential impacts of these concentration levels with respect to public health are assessed in Section 4.4.4.7.2.

4.4.4.7 Human Health and Safety

The assessment of potential human health and safety impacts from spills under the proposed action considers pipeline, Valdez Marine Terminal, and transportation spills, as

Impacts of Oil Spills on Human Health and Safety

Health and safety impacts were assessed for spills along the pipeline (both onto land and into rivers), at the Valdez Marine Terminal, along transportation routes, and for large spill-associated fires. A key endpoint evaluated for short-term impacts was the “impact distance,” defined as the distance from the spill boundary out to which there is the potential for serious adverse health impacts from inhalation of contaminants emitted from spills or fires. For spills and fires in the anticipated, likely, and unlikely/very unlikely categories, the maximum impact distances estimated were 0.02, 0.4, and 4 km, respectively. People who remain within these areas could experience serious health effects from spills.

For spills to rivers or Port Valdez, there is a concern about exposures from eating contaminated fish, shellfish, or marine mammals. Spills can cause tainting of large numbers of these species, making them noticeably unfit for human consumption (e.g., the fish would have visible oil on the surface or smell of oil). However, in cases where the food is not noticeably contaminated, this assessment showed that adverse health effects would not be expected from eating fish, shellfish, or marine mammals from a spill area.

TABLE 4.4-27 Estimated Emission Rates of Hazardous Air Pollutants from Evaporation of Spilled Materials without Associated Fire

	Maximum Emission Rate (lb/h)[a] per Type and Location of Spill and Expected Frequency Range of Spill (A, L, UL, and U/VU)[b]												
	Pipeline Spills at Fairbanks (Land)			Pipeline Spills on Yukon River (MP 353–354) (river)			Valdez Marine Terminal Spills (land/marine)				Roadway Spills (land)	
Chemical	A	L	U/VU	A	L	U/VU	A	L	UL	U/VU	U/VU - Turbine	U/VU - Diesel
Benzene	56.8	8,522	35,880	55.9	1,119	23,769	8.5	3,292	256	61,260	22.5	108
Cyclohexane	245	24,450	102,938	146	2,921	62,063	36.7	9,443	1,100	175,753	465	465
Ethylbenzene	1.6	108	455	9.3	186	3,961	0.2	41.7	7.3	777	2.1	3.1
n-Heptane	180	17,952	75,579	255	5,096	108,280	26.9	6,934	808	129,041	341	341
Hexane	292	29,212	122,984	146	2,921	62,063	43.8	11,738	1,315	259,421	555	555
Naphthalene	0.1	1.6	6.8	3.2	110	73.8	0.01	0.6	0.2	11.7	0.03	0.1
n-Octane	66	6,615	27,850	295	5,904	125,446	9.9	2,555	298	47,551	126	126
Styrene	6.3	627	2,642	78	1,554	28,338	0.9	242	28.2	4,510	11.9	11.9
Toluene	33	5,324	22,414	126	2,517	53,480	4.9	2,056	148	38,268	37.5	62.4
Xylene	10	901	3,791	78	1,554	33,012	1.4	348	43.0	6,473	17.1	18.1
Hydrogen sulfide	1.8	175	738	0.9	17.5	373	0.3	86.0	7.9	8,941	3.3	3.3

[a] Emission rate during the first hour after a spill at 60°F oil temperature and 3-m/s wind speed. The emission rate at 1.5 m/s would be about ≥58% of the listed values.

[b] A = anticipated event (>0.5/yr); L = likely event (0.03 to 0.5/yr); U = unlikely event (10^{-3} to 0.03/yr); and VU = very unlikely event (10^{-7} to 10^{-3}/yr).

[c] Small leak during pipeline or pump station operation; 1-in.-thick, 0.16-acre pool area.

[d] Leak due to sabotage, vandalism, or corrosion; assumption of 2.1-million-bbl/d throughput; 1-in.-thick, 15-acre pool area.

[e] Guillotine break due to a fixed-wing aircraft crash or seismic event; assumption of 2.1-million-bbl/d throughput; 1-in. thick, 65-acre pool area.

[f] Small leak during pipeline operation.

Footnotes continued on next page.

TABLE 4.4-27 (Cont.)

g Leak due to sabotage, vandalism, or corrosion; assumption of 2.1-million-bbl/d throughput.

h Guillotine break due to aircraft crash or impact of a helicopter; assumption of 2.1-million-bbl/d throughput.

i Small leak during Valdez Marine Terminal operations; 1-in.-thick, 0.02-acre pool area.

j Moderate leak of crude oil during Valdez Marine Terminal operations; total spill is 4,900 bbl, 3,200 bbl on ground (1-in.-thick, 7.5-acre pool area), 1,700 bbl in Port Valdez (2.6-in.-thick, 1.0-acre slick area).

k Spill due to fuel line rupture; 1-in.-thick, 0.7-acre pool area.

l Catastrophic storage tank rupture at Valdez Marine Terminal due to foundation or welding failure; total spill is 510,000 bbl, of which 316,000 bbl remain in secondary containment (49.9-in.-thick, 10-acre pool area), 50,350 bbl reach land outside secondary containment (5.2-in.-thick, 15-acre pool area), and 143,450 bbl reach Port Valdez (2.6-in.-thick, 86-acre slick area).

m Rollover of a tanker truck carrying turbine or diesel fuel; 1-in.-thick, 0.3-acre pool area.

outlined in Section 4.4.1. The assessment addresses four exposure categories: (1) potential for impacts from exposures to soils and groundwater contaminated due to spills to land; (2) impacts from inhalation exposures resulting from pipeline spills to land or rivers, Valdez Marine Terminal spills, transportation spills, or hazardous material spills; (3) impacts from inhalation exposures resulting from fires; and (4) impacts from foodchain exposures subsequent to spills to water.

In general, the spill scenarios considered were the pipeline and Valdez Marine Terminal scenarios in each of four frequency categories (i.e., *anticipated*, *likely*, *unlikely*, and *very unlikely*) that would result in the highest impacts. Spills of crude oil, diesel, or turbine fuel are included in this assessment, as well as spills of other hazardous materials stored or transported. In general, the volumes of spills of refined oil products considered were smaller than those of crude oil spills. The highest impacts of the spills generally would be associated with the spill in each frequency category with the highest volume. Hypothetical spill locations were selected to be close to actual human populations. For example, the inhalation impacts from pipeline spills were assessed for the pipeline location nearest to a residential area of Fairbanks (MP 456).

The assessment of human health and safety impacts from spills is limited to impacts to the general public and does not include occupational exposures for cleanup workers or TAPS employees at the pump stations or Valdez Marine Terminal. Protection of these workers is regulated under the Occupational Health and Safety Act and is beyond the scope of this assessment. However, it is important to emphasize that minimizing the exposures of spill cleanup workers is a very important consideration. For example, allegations have been made of serious, chronic health effects to workers who participated in the cleanup of the Exxon Valdez oil spill in 1989 (Murphy 2001). Former workers allege that during the massive cleanup operation, appropriate protective equipment was not always available and procedures to protect worker health were not always followed. Some former workers claim that the oil and solvent exposures have resulted in a wide range of respiratory and other illnesses. Out of 15,000 workers involved in the cleanup, 25 have filed suit for damages. Of these claims, 7 have been settled, 8 have been dismissed, and 10 are pending (Murphy 2001).

4.4.4.7.1 Impacts from Exposures to Contaminated Soils and Groundwater Resulting from Spills to Land. Spills of crude oil, diesel, gasoline, or turbine fuel to land could occur at any point along the pipeline, at the pump stations, at the Valdez Marine Terminal, or along transportation routes (see scenarios presented in Section 4.4.1). Projected spill volumes range from about 10 to 50,000 bbl; the highest volumes are projected for crude oil spills and are associated with unlikely or very unlikely scenarios.

The potential for ingestion or dermal exposure of the general public to soils and groundwater contaminated because of spills is very low, because of extensive regulation of the containment and cleanup of spill sites. Public access to spill sites is restricted, and in most cases, contamination of groundwater is prevented by timely removal of soil contamination. If groundwater contamination does occur, measures are taken to prevent public use of the water. Potential inhalation exposures to contaminants volatilizing from a spill are addressed below in Section 4.4.4.7.2. Details on State of Alaska containment and cleanup requirements after a spill occurs are provided in the following paragraphs.

The State of Alaska cleanup program seeks to identify the risks associated with each contaminated site and to prioritize sites for cleanup on the basis of the risks posed. State involvement in the cleanup may range from total control to simple oversight of the responsible parties. Liability for state costs and damages are assigned to the persons identified as responsible for the contamination (ADEC 2001a).

Alaska statutes require the ADEC to prescribe general methods and procedures for containment and cleanup of hazardous substance releases. This state guidance is contained in numerous documents[7] that detail specific aspects of the required actions for contaminated site remediation. Overall, the process involves the following elements or phases: site discovery, site characterization, cleanup decision, cleanup, and site closure.

The *site discovery phase* involves collection and confirmation of information regarding the extent and severity of contamination. It also may involve emergency actions to protect human health. If there is risk to the public, notification takes place at this stage. A preliminary risk rank is assigned to the site based on the risk to both the public and the environment. Responsible parties are identified, and the management responsibility for site remediation is established.

The *site characterization phase* involves more detailed information gathering on the site and contaminants, including field sampling and investigation. Potential risks to human health and the environment are evaluated, as are potential cleanup technologies. The responsible parties are required to submit a report that details the conclusions regarding the nature and extent of contamination, the human and environmental hazards, calculation of cleanup levels, and recommendation of cleanup technologies to be applied.

Five criteria are specified for consideration of cleanup alternatives: protectiveness of human health and the environment; practicability; short- and long-term effectiveness; compliance with state and federal regulations; and community input. Generic State of Alaska cleanup levels have been established for soil, groundwater, and surface water. The generic cleanup levels for oil-related contaminants are listed in Table 4.4-28. Site-specific cleanup reports must specify whether generic State of Alaska cleanup levels are recommended or whether alternative levels are sought on the basis of site-specific calculations or a risk assessment. The ADEC specifies four methods for developing site-specific alternate cleanup levels. These methods vary, depending on whether or not Arctic Zone soils are involved and whether the contaminants are limited to petroleum hydrocarbons or not. Methods may also be modified, depending on whether standard equations or a transport model are used to estimate contaminant migration to groundwater. Finally, the cleanup levels may be based on a detailed risk assessment that considers potential pathways of exposure to assess the likelihood of adverse human health or environmental effects. Procedures for conducting such risk assessments are specified in the Risk Assessment Procedures Manual (ADEC 2000). The manual sets out detailed requirements for identifying exposure pathways, assessing toxicity, and characterizing health risks.

On the basis of the information provided, during the *decision phase* the ADEC develops a decision document that specifies the cleanup requirements. The *cleanup phase* includes development of a detailed cleanup plan, followed by implementation of the cleanup under ADEC oversight. Completion is documented in a report. Finally, in the *site closure phase*, sites are either completely closed out of the supervision process or designated for longer-term monitoring, depending on the effectiveness of the cleanup.

Because spills onto gravel or soil surfaces must be cleaned up according to these ADEC requirements, there should be no complete exposure pathways or elevated concentrations remaining after remediation of these types of spill sites and, therefore, no long-term health impacts from exposure to contaminants in soil. In particular, the risk assessments conducted for these sites under the ADEC Site Contamination Program are intended to ensure that spills to soil will not result in potential human health risks from the exposure pathways of direct contact or leaching to groundwater. For example, APSC has used the above procedures in assessing the potential for adverse impacts to human health or the environment from construction-era releases at Happy Valley Camp and recommending risk-based corrective action (OASIS Environmental 1998).

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7 The guidance documents are available on the Internet at http://www.state.ak.us/local/akpages/ENV.CONSERV/dspar/csites/ind_docs.htm.

TABLE 4.4-28 Alaska Cleanup Levels for Hydrocarbon-Contaminated Soil[a,b]

Product	Parameter/ Constituent	Cleanup Level (mg/kg) Method 1[c]	Method 2[d]
Gasoline	GRO (C6-C10)	50–1,000	260–1,400
	(C6-C10) Aliphatic hydrocarbons		240–1,000
	(C6-C10) Aromatic hydrocarbons		130–1,000
	Benzene		0.02–390
	Toluene		4.8–27,400
	Ethyl benzene		5.0–13,700
	Xylenes		69–274,000
	Naphthalene		38–5,500
Diesel	GRO (C6-C10)	50–1,000	260–1,400
	(C6-C10) Aliphatic hydrocarbons		240–1,000
	(C6-C10) Aromatic hydrocarbons		130–1,000
	DRO C10-C25	100–2,000	230–12,500
	C10-C25 Aliphatic hydrocarbons		6,400-10,000
	C10-C25 Aromatic hydrocarbons		90–5,000
	Benzene		0.02–390
	Toluene		4.8–27,400
	Ethylbenzene		5.0–13,700
	Xylenes		69–274,000
	PAHs:		
	Naphthalene		38–5,500
	Fluorene		240–5,500
	Anthracene		3,900–41,000
	Pyrene		1,400–4,100
	Benzo(a)anthracene		5.5–15
	Acenaphthene		190–8,200
	Chrysene		550–1,500
	Benzo(a)pyrene		0.9–3
	Dibenzo(a,h)anthracene		0.9–6
	Benzo(b)fluoranthene		9–20
	Benzo(k)fluoranthene		93–200
	Indeno(1,2,3-c,d)pyrene		9–54
Waste Oil	GRO (C6-C10)	50–1,000	260–1,400
	(C6-C10) Aliphatic hydrocarbons		240–1,000
	(C6-C10) Aromatic hydrocarbons		130–1,000
	DRO C10-C25	100–2,000	230–12,500
	C10-C25 Aliphatic hydrocarbons		6,400–10,000
	C10-C25 Aromatic hydrocarbons		90–5,000
	RRO C25-C36	2,000	9,700–22,000
	C25-C36 Aliphatic hydrocarbons		20,000
	C25-C36 Aromatic hydrocarbons		2,500–10,000

TABLE 4.4-28 (Cont.)

Product	Parameter/ Constituent	Cleanup Level (mg/kg) Method 1[c]	Method 2[d]
	Benzene		0.02–390
	Toluene		4.8–27,400
	Ethyl benzene		5.0–13,700
	Xylenes		69–274,000
	PAHs:		
	Naphthalene		38–5,500
	Fluorene		240–5,500
	Anthracene		3,900–41,000
	Pyrene		1,400–4,100
	Benzo(a)anthracene		5.5–15
	Acenaphthene		190–8,200
	Chrysene		550–1,500
	Benzo(a)pyrene		0.9–3
	Dibenzo(a,h)anthracene		0.9–6
	Benzo(b)fluoranthene		9–20
	Benzo(k)fluoranthene		93–200
	Indeno(1,2,3-c,d)pyrene		9–54
	Metals:[e]		
	Arsenic		1.8–8
	Barium		982–9,600
	Cadmium		4.5–140
	Chromium		23–680
	Chromium(III)		83,000–>106
	Chromium(VI)		23–680
	Lead: residential		400
	Lead: industrial		1,000
	Nickel		78–2,700
	Vanadium		580–3,400

[a] Soil cleanup levels are from the Oil and Hazardous Substances Pollution Control Regulations, 18 AAC 75, Article 3.

[b] There are also site-specific methods for determining alternate soil cleanup levels.

[c] Method 1 involves a table to determine the soil cleanup level for three different hydrocarbon ranges:

GRO: gasoline range organics
DRO: diesel range organics
RRO: residual range organics

[d] Method 2 involves soil cleanup levels that were designed to protect humans from three different potential exposure pathways: direct ingestion of soil, inhalation of volatile contaminants, and migration from soil to groundwater and the subsequent ingestion of contaminated groundwater.

[e] Metals analyses required on a site-by-site basis.

4.4.4.7.2 Impacts from Inhalation Exposures Resulting from Spills. This section assesses the potential for adverse health impacts resulting from inhalation of contaminants volatilized from spills along the pipeline, spills at the Valdez Marine Terminal, spills during transportation accidents, and spills to rivers along the pipeline (see Sections 4.4.1 and 4.4.2). Spill scenarios along the pipeline and at pump stations encompass maximum volumes of 100 bbl of diesel for *anticipated* events (e.g., small leak during operations), 10,000 bbl of crude oil for likely events (e.g., corrosion or sabotage), and 42,101 bbl of crude oil for *unlikely* or *very unlikely* events (e.g., a guillotine break due to aircraft crash or seismic landslide). Spill scenarios at the Valdez Marine Terminal encompass maximum volumes of 15 bbl of diesel for *anticipated* events, 3,200 bbl of crude oil to land and 1,700 bbl to Port Valdez for *likely* events, 450 bbl of diesel for *unlikely* events, and a *very unlikely* aircraft crash into a storage tank in which about 316,000 bbl is released into a containment area, 50,000 bbl is released outside of containment, and 143,000 bbl flows into Port Valdez. Transportation spill scenarios involve release of 190 bbl of turbine fuel for *unlikely* events and 190 bbl of diesel or turbine fuel for *very unlikely* events. River spill scenarios assessed involve release of 10,000 bbl of oil for *likely* events and 21,246 bbl of oil for *unlikely/very unlikely* events.

Potential inhalation was modeled for the volatile components of spilled substances for the various scenarios and volumes. A range of conditions was assessed, including typical and worst-case meteorological conditions (D atmospheric stability and 3 m/s wind speed for typical case; F stability and 1.5 m/s wind speed for worst case), and, where appropriate, a 1- to 3-in. oil pool depth. A method to estimate air emissions to aid in spill response procedures developed for APSC (IT Alaska 2001) and using the EPA's ISCST model (EPA 1995) was used in this analysis. Details on the modeling are provided in Section 4.4.4.6 and Appendix A, Section A.4.

Ten volatile crude oil, diesel, and turbine fuel components of greatest concern with respect to toxicity were identified (Goldstein et al. 1992). The assumed percent composition of these substances in the current TAPS crude oil mix was not available, so existing information was used to estimate the composition. Percent composition values used in this assessment, as well as emission estimates for modeled spills, are presented in Section 4.4.4.6.

In general, there are no federal or state standards for evaluating the impacts of isolated exposures resulting from accidental releases. However, two groups have analyzed available toxicological data for various chemicals and have derived levels of concern for short exposures of the general public to these chemicals. Emergency response planning guideline (ERPG) levels have been derived by the American Conference of Governmental Industrial Hygienists (AIHA 2001) for about 100 substances, and temporary emergency exposure limits (TEELs) have been derived by a DOE working group for about 1,700 additional substances (Westinghouse Safety Management Solutions 2002). The ERPG levels are specifically derived for comparison with exposures of 1-hour duration or less; the TEEL values are derived for comparison with exposures of 15 minutes or less. To evaluate short-term inhalation exposures to the toxic volatile components of crude oil, diesel, and turbine fuel, the use of ERPG levels was preferred in this assessment, because these levels incorporate more chemical-specific toxicity data and have received a greater degree of review.

To assess whether adverse impacts would be associated with inhalation of the volatile components of a spill, the estimated maximum concentrations at the boundary of the spill area were compared with a range of levels that could cause health effects ranging from mild transient adverse effects up to serious irreversible effects that could impair an individual's ability to take protective action (ERPG and TEEL values; see footnotes to impact tables cited below for complete definitions). The assessment also provides an impact distance for the oil spills, defined as the distance from the boundary of the spill area to the location where the ambient air concentration drops below the ERPG-2 or TEEL-2 value. It would be recommended that any members of the general population within the impact distance downwind of an oil spill be evacuated for a period of several hours up to 24 hours until the plume caused by the emitted air pollutants could dissipate. (It is estimated that VOC emissions from a crude oil spill are generally negligible about 24 hours after the initial spill [IT Alaska 2001]).

Pipeline Spills. For pipeline spills, a spill near a Fairbanks residential area at MP 456 was modeled because it was considered to represent the worst-case exposure situation along the pipeline (that is, the place where members of the general public would be closest to the spill location). At this aboveground pipeline location, residences are located about 33 m from the pipeline. For the *unlikely* or *very unlikely* guillotine break scenarios, the maximum spill volume for this location was at a throughput of 2.1×10^6 bbl/d, and was estimated to be 42,101 bbl. Although for the scenarios modeled, a specific pipeline location was assumed (i.e., MP 456 near Fairbanks), these impact estimates can be considered bounding for similar spill volumes at any location along the pipeline.

For *anticipated* spills along the pipeline, the assessment examined a spill of 100 bbl of diesel. Because this spill volume is relatively small, only a 1-in. diesel pool depth was modeled (this results in a large pool size and higher estimated air concentrations). For this spill under maximum hazard weather conditions (F stability, 1.5 m/s wind speed), maximum concentrations of benzene and toluene in the first hour after the spill (490 and 300 mg/m^3, respectively) would exceed the comparison levels for mild adverse effects at the edge of the spill area, but the concentrations of both would be less than the comparison values for serious effects at the edge of the spill area (see Table 4.4-29 for comparison levels). The compound n-hexane would have a maximum concentration of 2,100 mg/m^3 and an impact distance of 0.02 km. Under more typical, minimum hazard weather conditions (D stability, 3 m/s wind speed), the maximum concentrations of benzene, toluene, and n-hexane would decrease to 240, 150, and 820 mg/m^3, respectively, and the impact distance for hexane would decrease to 0.01 km.

Hazard Conditions

For the assessment of inhalation impacts from spills, typical weather conditions are represented by a meteorology of Class D atmospheric stability and 3 m/s wind speeds, and worst-case weather conditions are represented by Class F atmospheric stability and 1 m/s wind speed. Minimum hazard conditions are represented by the combination of typical weather conditions (D stability, 3 m/s wind speed) and a 3-in. oil pool depth. Maximum hazard conditions are represented by the combination of worst-case weather conditions (F stability, 1 m/s wind speed) and a 1-in. oil pool depth.

The impacts of *likely* spills were assessed by assuming a 10,000 bbl release. Impact estimates for that release are given in Table 4.4-29. Under maximum hazard conditions, concentrations of benzene, n-heptane, hexane, toluene, and hydrogen sulfide would exceed the comparison concentrations at the edge of the spill area in the first hour after the spill, with the maximum impact distance extending to 0.44 km downwind of the spill area. Under minimum hazard conditions, benzene, toluene, and hydrogen sulfide would exceed the comparison levels for mild adverse effects, but the concentrations would be less than the comparison values for serious effects at the edge of the spill area. The impact distance for n-hexane would be 0.04 km.

The impacts for the *unlikely* and *very unlikely* scenarios (guillotine breaks) are also summarized in Table 4.4-29. Under maximum hazard conditions, concentrations of benzene, cyclohexane, n-heptane, n-hexane, toluene, and hydrogen sulfide would exceed the comparison concentrations at the edge of the spill area in the first hour after the spill, with the maximum impact distance extending to 1.3 km downwind of the spill area. For minimum hazard conditions, benzene, toluene, and hydrogen sulfide would exceed the comparison levels for mild adverse effects, but the concentrations would be less than the comparison values for serious effects at the edge of the spill area. The impact distance for n-hexane would be 0.1 km.

TABLE 4.4-29 Inhalation Impacts of Pipeline Spills: Maximum 1-Hour Pollutant Concentrations and Impact Distances

	Maximum Hazard[a]				Minimum Hazard[a]				
	Very Unlikely or Unlikely Scenario[b] (42,101 bbl)		Likely Scenario[c] (10,000 bbl)		Very Unlikely or Unlikely Scenario[b] (42,101 bbl)		Likely Scenario[c] (10,000 bbl)		
Compound	Maximum 1-Hour Concentration (mg/m^3)	Impact Distance[d] (km)	Maximum 1-Hour Concentration (mg/m^3)	Impact Distance[d] (km)	Maximum 1-Hour Concentration (mg/m^3)	Impact Distance[d] (km)	Maximum 1-Hour Concentration (mg/m^3)	Impact Distance[d] (km)	Comparison Concentration[e] (mg/m^3)
Volatile organic compounds									
Benzene	1,250	0.17	1,000	0.06	490	-[f]	400	-	150–500 (ERPG)
Cyclohexane	3,600	-	2,900	-	1,400	-	1,200	-	3,000–4,000
Ethyl benzene	16	-	13	-	6.2	-	5.1	-	500
n-Heptane	2,600	0.06	2,200	0.02	1,000	-	850	-	1,500
n-Hexane	5,300	1.3	4,300	0.44	2,100	0.1	1,700	0.04	500–750
Naphthalene	0.2	-	0.2	-	0.1	-	0.1	-	75–150
n-Octane	970	-	790	-	380	-	310	-	1,500
Styrene	92	-	76	-	36	-	30	-	200–1,000 (ERPG)
Toluene	780	-	640	-	300	-	250	-	150–1,000 (ERPG)
Xylene	130	-	110	-	51	-	43	-	600–750
Inorganic compounds									
Hydrogen sulfide	44	0.01	36	-	30	-	25	-	20–40 (ERPG)

See footnotes on next page.

TABLE 4.4-29 (Cont.)

a Maximum and minimum hazards reflect differences in assumed oil pool depth and meteorological conditions at the time of the spill. Maximum hazards occur under meteorological conditions of F stability with 1.5 m/s wind speed and an oil pool depth of 1 in., whereas minimum hazards occur under D stability with 3 m/s wind speed and an oil pool depth of 3 in.

b Guillotine break due to aircraft crash or seismic event at MP 456. For maximum hazard scenario, the length and area of the spill are 0.35 km and 65 acres; for minimum hazard scenario, length and area of the spill are 0.2 km and 22 acres. Maximum concentration locations are at the boundary of spill area.

c Leak resulting from sabotage or corrosion at MP 456. For maximum hazard scenario, length and area of the spill are 0.2 km and 15 acres; for minimum hazard scenario, length and area of the spill are 0.1 km and 5 acres. Maximum concentration locations are at boundary of spill area.

d Impact distance is the distance from the boundary of the spill area to the location where the ambient air concentration drops below the ERPG-2 or TEEL-2 value.

e The range is from Emergency Response Planning Guideline 1 (ERPG-1) to ERPG-2, where ERPG values are available (EPA 2001c). Otherwise, Temporary Emergency Exposure Limit 1 (TEEL-1) and TEEL-2 values were used. ERPG and TEEL definitions are almost identical, except ERPGs are for 1-hour exposures, while TEELs are for 15-minute exposures. Definitions: ERPG-1 (TEEL-1) = the maximum concentration in air below which it is believed nearly all individuals could be exposed for up to 1 hour (up to 15 minutes) without experiencing other than mild transient adverse health effects or perceiving a clearly defined objectionable odor. ERPG-2 (TEEL-2) = the maximum concentration in air below which it is believed nearly all individuals could be exposed for up to 1 hour (up to 15 minutes) without experiencing or developing irreversible or other serious health effects or symptoms that could impair their abilities to take protective action. It is recommended that for application of TEELs, concentration at the receptor point of interest be calculated as the peak 15-minute time-weighted average concentration. Therefore, the comparison with TEELs may be underprotective.

f A dash indicates predicted concentrations are lower than the ERPG-2 or TEEL-2 comparison levels over the entire modeling domain.

Valdez Marine Terminal Spills. For Valdez Marine Terminal scenarios, diesel spills for the *anticipated* and *unlikely* scenarios were postulated to occur outside of containment (release of less than a gallon to Port Valdez for the *anticipated* scenario was assumed to have negligible impacts with respect to inhalation). The areas covered for a 1-in. oil pool depth for *anticipated* and *unlikely* scenarios were 0.02 acres and 0.7 acres, respectively. For the *likely* scenario of a moderate leak during Valdez Marine Terminal operations, volatilization from two areas was accounted for: a 5-acre land area where the oil pool would have a 1-in. thickness, and a 1-acre area of Port Valdez to which about 1,700 bbl of oil would flow. For the *very unlikely* scenario of a catastrophic rupture of a crude oil storage tank, volatilization from three areas was accounted for: a 10-acre containment area, a 15-acre additional land area for overflow oil outside of containment, and an 86-acre area of Port Valdez to which about 143,000 bbl of oil would flow. For modeling the Port Valdez contaminated areas, it was assumed that booms would be used, thus containing the oil to a concentration of about 1.69 gal/ft^2 (APSC 2001h), corresponding to about a 2.6-in. thickness on the surface of the water. For Valdez Marine Terminal spills, the impact distances were compared with the distance to residential areas of Valdez, located as close as 3.2 km (2 mi) to the Valdez Marine Terminal.

For *anticipated* spills, the assessment examined a spill of 15 bbl of diesel. Because this spill volume is relatively small, only a 1-in. diesel pool depth was modeled. For this spill under maximum hazard weather conditions, the concentration of benzene at the edge of the spill area (220 mg/m^3) in the first hour after the spill would exceed the comparison level for mild adverse effects, but it would be less than the comparison value for serious effects. The compound n-hexane would have a maximum concentration of 1,400 mg/m^3 and an impact distance of less than 0.01 km. Under more typical weather conditions (D stability, 3 m/s wind speed), the maximum concentration of n-hexane at the edge of the spill area (560 mg/m^3) would exceed the comparison level for mild adverse effects, but it would be less than the comparison value for serious effects. This spill would not affect residential areas of Valdez.

The impacts of *likely* spills are summarized in Table 4.4-30. Under maximum hazard conditions, concentrations of benzene, n-heptane, n-hexane, toluene, and hydrogen sulfide would exceed the comparison concentrations at the edge of the spill area in the first hour after the spill, with the maximum impact distance extending to 0.2 km downwind of the spill area. Under minimum hazard conditions, benzene and toluene would exceed the comparison levels for mild adverse effects, but the concentrations would be less than the comparison values for serious effects at the edge of the spill area. The impact distance for n-hexane would be 0.02 km. This spill would not impact residential areas of Valdez.

The *unlikely* spill at the Valdez Marine Terminal is for 450 bbl of diesel, a substantially lower volume than for the *likely* spill assessed. As would be expected, the modeled impacts are lower. Under maximum hazard conditions, 1-hour concentrations of benzene, toluene, and hydrogen sulfide (430, 250, and 22 mg/m^3, respectively) would exceed the comparison concentrations for mild impacts, but not for serious impacts. The impact distance for n-hexane (maximum concentration of 2,700 mg/m^3) would be 0.05 km, so the plume would be very small and would not reach Valdez residential areas.

The impacts for the *very unlikely* scenario (catastrophic rupture of crude oil storage tank) are also summarized in Table 4.4-30. Under maximum hazard weather conditions, concentrations of benzene, cyclohexane, n-heptane, n-hexane, toluene, and hydrogen sulfide would exceed the comparison concentrations at the edge of the Port Valdez spill area in the first hour after the spill. The highest impact distance could extend up to 4.0 km (2.5 mi) downwind of the Port Valdez spill area. For an assumed contained oil area on Port Valdez extending approximately 0.8 km (0.5 mi) north of the Valdez Marine Terminal, this impact distance would intersect the residential areas of Valdez (if the wind were blowing toward the city). Under the more typical minimum hazard weather conditions, the maximum impact distance would be 0.3 km (0.2 mi), and the plume would not reach Valdez residential areas.

TABLE 4.4-30 Inhalation Impacts of Valdez Marine Terminal Spills: Maximum 1-Hour Pollutant Concentrations and Impact Distances

	Maximum Hazard[a]				Minimum Hazard[a]				
	Very Unlikely or Unlikely Scenario[b] (510,000 bbl)		Likely Scenario[c] (4,900 bbl)		Very Unlikely or Unlikely Scenario[b] (510,000 bbl)		Likely Scenario[c] (4,900 bbl)		
Compound	Maximum 1-Hour Concentration (mg/m^3)	Impact Distance[d] (km)[e]	Maximum 1-Hour Concentration (mg/m^3)	Impact Distance[d] (km)	Maximum 1-Hour Concentration (mg/m^3)	Impact Distance[d] (km)	Maximum 1-Hour Concentration (mg/m^3)	Impact Distance[d] (km)	Comparison Concentration[e] (mg/m^3)
Volatile organic compounds									
Benzene	1,500	0.38	870	0.02	600	0.19	400	-[f]	150-500 (ERPG)
Cyclohexane	4,200	0.01	2,500	-	1,700	-	1,200	-	3,000–4,000
Ethyl benzene	18	-	11	-	7.7	-	5.1	-	500
n-Heptane	3,100	0.15	1,800	0.01	1,300	-	850	-	1,500
n-Hexane	6,100	2.1	3,700	0.2	2,600	0.31	1,400	0.02	500–750
Naphthalene	0.28	-	0.17	-	0.12	-	0.08	-	75–150
n-Octane	1,100	-	670	-	470	-	310	-	1,500
Styrene	110	-	64	-	44	-	30	-	200–1,000 (ERPG)
Toluene	910	-	540	-	380	-	250	-	150–1,000 (ERPG)
Xylene	150	-	92	-	64	-	43	-	600–750
Inorganic compounds									
Hydrogen sulfide	500	4.0	31	-	110	0.13	8.3		20–40 (ERPG)

a Maximum and minimum hazards reflect differences in assumed meteorological conditions at the time of the spill. Maximum hazards occur under meteorological conditions of F stability with 1.5 m/s wind speed; minimum hazards occur under D stability with 3 m/s wind speed.

b Catastrophic storage tank rupture caused by aircraft crash (includes 316,000 bbl oil released into containment area [10 acres], 50,350 bbl released to secondary containment [15 acres], and 143,450 bbl released to water but contained by booms [86 acres]). Maximum concentration location is at boundary of spill area (about 0.8 km north of the Valdez Marine Terminal in Port Valdez); air modeling accounts for each component of spill area.

Footnotes continued on next page.

TABLE 4.4-30 (Cont.)

c Moderate leak during operations of 3,200 bbl crude oil outside containment (5 acres) and 1,700 bbl to water but contained by booms (1 acre). Maximum concentration location is at boundary of spill area (about 0.2 km north of the Valdez Marine Terminal in Port Valdez); air modeling accounts for each component of spill area.

d Impact distance is the distance from the boundary of the Port Valdez spill area to the location where the ambient air concentration drops below the ERPG-2 or TEEL-2 value.

e The range is from Emergency Response Planning Guideline 1 (ERPG-1) to ERPG-2, where ERPG values are available (EPA 2001c). Otherwise, Temporary Emergency Exposure Limit 1 (TEEL-1) and TEEL-2 values were used. ERPG and TEEL definitions are almost identical, except ERPGs are for 1-hour exposures while TEELs are for 15-minute exposures. Definitions: ERPG-1 (TEEL-1) = the maximum concentration in air below which it is believed nearly all individuals could be exposed for up to 1 hour (up to 15 minutes) without experiencing other than mild transient adverse health effects or perceiving a clearly defined objectionable odor. ERPG-2 (TEEL-2) = the maximum concentration in air below which it is believed nearly all individuals could be exposed for up to 1 hour (up to 15 minutes) without experiencing or developing irreversible or other serious health effects or symptoms that could impair their abilities to take protective action. It is recommended that for application of TEELs, concentration at the receptor point of interest be calculated as the peak 15-minute time-weighted average concentration. Therefore, the comparison with TEELs may be underprotective.

f A dash indicates predicted concentrations are lower than the ERPG-2 or TEEL-2 comparison levels over the entire modeling domain.

Transportation Spills. Impacts of transportation spills are summarized in Table 4.4-31. For both the *unlikely* scenario (190 bbl of turbine fuel), and the *very unlikely* scenario (190 bbl of diesel), only n-hexane exceeds the comparison values, with an impact distance ranging from 0.003 to 0.03 km, depending on the hazard conditions at the time of the accident. For the *very unlikely* scenario, toluene also exceeds the comparison value for mild impacts.

Inhalation Exposure Impacts from Spills to Rivers. To assess whether spills to rivers could result in adverse impacts from inhalation of volatile components for receptors along the river banks, spills representing a range of possible impacts were evaluated. The modeling of this scenario is somewhat complex because the source would be moving away from the receptor with the river current. Modeling assumptions are provided in Section 4.4.4.6. For each scenario modeled, the receptor was assumed to be at the aboveground river crossing release point, which would be the location of maximum air concentrations of contaminants.

On the basis of the discussion of possible spills to rivers provided in Section 4.4.4.3 and the modeling for *likely* and *unlikely/very unlikely* categories (see below), spills in the *anticipated* category (up to 100 bbl of diesel) were considered to have negligible inhalation impacts and were not assessed quantitatively.

For the *likely* category spill, a 10,000 bbl spill to the Yukon River was assessed. Because of the large surface area over which the spill could spread (the width of the Yukon ranges from 1,500 to 4,000 ft), the modeled air concentrations from a spill to the Yukon would be higher than for the narrower rivers. Table 4.4-32 summarizes the impacts from the likely spill. No comparison values would be exceeded at the river bank for any of the volatile contaminants modeled.

For the *unlikely/very unlikely* spill categories, a guillotine break releasing 21,246 bbl of crude oil to the Yukon River was assessed. Under maximum hazard weather conditions, concentrations of benzene, n-heptane, n-hexane, toluene, and hydrogen sulfide would exceed the comparison concentrations. The highest impact distance could extend up to 1.2 km (0.75 mi) from the river bank. For minimum hazard conditions, concentrations of benzene and toluene would exceed the comparison levels for mild impacts, and the impact distance for n-hexane could extend up to 0.03 km (0.02 mi) from the river bank.

Uncertainties in the Inhalation Impacts Assessment. Several areas of conservatism and uncertainty in the assessment of ambient air concentrations and estimation of impact distances that should be noted. As discussed in Section 4.4.1.3, the method used to calculate the spill areas results in overestimates, primarily because absorption into the soil and terrain features are not accounted for. Also, the modeling relies on estimates of percent composition of the individual substances modeled in the crude oil (see Section 4.4.4.6). Data for the current TAPS crude mix were not available, so several sources of data were combined for this assessment (Roehner 2001; National Research Council 1985; Riley 1980). For cyclohexane, n-hexane, n-heptane, and n-octane, only the percent compositions for the total 6-carbon, 7-carbon, and 8-carbon components in the TAPS mix crude were available (Roehner 2001). In the absence of chemical-specific percent composition data, each of the four substances was assumed to make up 50% of its corresponding carbon component (e.g., the percent composition of cyclohexane was assumed to be 50% of the total C6 fraction, reported as 1.925%). A chemical-specific laboratory analysis of the current TAPS crude oil mix would allow much more accurate estimation of the expected downwind concentrations for each of the modeled substances.

For the substances for which ERPG values were not available, an additional uncertainty was introduced in that the TEEL values are actually derived for comparison with 15-minute exposure levels. Therefore, comparison of the maximum 1-hour estimated ambient concentrations with the TEEL values may be underprotective.

TABLE 4.4-31 Inhalation Impacts of Transportation Spills: Maximum 1-Hour Pollutant Concentrations and Impact Distances

	Maximum Hazard[a]				Minimum Hazard[a]				
	Unlikely Scenario[b] (190 bbl turbine fuel)		Very Unlikely Scenario[c] (190 bbl diesel)		Unlikely Scenario[b] (190 bbl turbine fuel)		Very Unlikely Scenario[c] (190 bbl diesel)		
Compound	Maximum 1-Hour Concentration (mg/m^3)	Impact Distance[d] (km)	Maximum 1-Hour Concentration (mg/m^3)	Impact Distance[d] (km)	Maximum 1-Hour Concentration (mg/m^3)	Impact Distance[d] (km)	Maximum 1-Hour Concentration (mg/m^3)	Impact Distance[d] (km)	Comparison Concentration[e] (mg/m^3)
Volatile organic compounds									
Benzene	76	-[f]	370	-	37	-	180	-	150–500 (ERPG)
Cyclohexane	1,600	-	1,600	-	760	-	760	-	3,000–4,000
Ethyl benzene	7.0	-	10	-	3.4	-	5.1	-	500
n-Heptane	1,200	-	1,200	-	560	-	560	-	1,500
n-Hexane	2,300	0.03	2,300	0.03	910	0.003	910	0.003	500–750
Naphthalene	0.10	-	0.36	-	0.05	-	0.17	-	75–150
n-Octane	430	-	430	-	210	-	210	-	1,500
Styrene	40	-	40	-	20	-	20	-	200–1,000 (ERPG)
Toluene	130	-	210	-	62	-	100	-	150–1,000 (ERPG)
Xylene	58	-	61	-	28	-	30	-	600–750
Inorganic compounds									
Hydrogen sulfide	19	-	19	-	5.5	-	5.5		20–40 (ERPG)

[a] Maximum and minimum hazards reflect differences in assumed meteorological conditions at the time of the spill. Maximum hazards occur under meteorological conditions of F stability with 1.5 m/s wind speed, whereas minimum hazards occur under D stability with 3 m/s wind speed.

[b] Overturn of a liquid turbine fuel truck between the Petro Star Refinery to PS12, or between the North Pole Refinery to PS 9. For maximum and minimum hazard scenarios, the length and area of the spill are 24 m and 0.3 acres. Maximum concentration locations are at the boundary of spill area.

[c] Overturn of a fuel truck carrying arctic grade diesel between the North Pole Refinery to PS 12. For maximum and minimum hazard scenarios, the length and area of the spill are 24 m and 0.3 acres. Maximum concentration locations are at boundary of spill area.

Footnotes continued on next page.

TABLE 4.4-31 (Cont.)

[d] Impact distance is the distance from the boundary of the spill area to the location where the ambient air concentration drops below the ERPG-2 or TEEL-2 value.

[e] The range is from Emergency Response Planning Guideline 1 (ERPG-1) to ERPG-2, where ERPG values are available (EPA 2001c). Otherwise, Temporary Emergency Exposure Limit 1 (TEEL-1) and TEEL-2 values were used. ERPG and TEEL definitions are almost identical, except ERPGs are for 1-hour exposures while TEELs are for 15-minute exposures. Definitions: ERPG-1 (TEEL-1) = the maximum concentration in air below which it is believed nearly all individuals could be exposed for up to 1 hour (up to 15 minutes) without experiencing other than mild transient adverse health effects or perceiving a clearly defined objectionable odor. ERPG-2 (TEEL-2) = the maximum concentration in air below which it is believed nearly all individuals could be exposed for up to 1 hour (up to 15 minutes) without experiencing or developing irreversible or other serious health effects or symptoms that could impair their abilities to take protective action. It is recommended that for application of TEELs, concentration at the receptor point of interest be calculated as the peak 15-minute time-weighted average concentration. Therefore, the comparison with TEELs may be underprotective.

[f] A dash indicates predicted concentrations are lower than the ERPG-2 or TEEL-2 comparison levels over the entire modeling domain.

TABLE 4.4-32 Inhalation Impacts of Spills to Rivers: Maximum 1-Hour Pollutant Concentrations and Impact Distances

	Maximum Hazard[a]				Minimum Hazard[a]				
	Likely Scenario[b] (10,000 bbl)		Unlikely/Very Unlikely Scenario[c] (21,246 bbl)		Likely Scenario[b] (10,000 bbl)		Unlikely/Very Unlikely Scenario[c] (21,246 bbl)		
Compound	Maximum 1-Hour Concentration (mg/m^3)	Impact Distance[d] (km)	Maximum 1-Hour Concentration (mg/m^3)	Impact Distance[d] (km)	Maximum 1-Hour Concentration (mg/m^3)	Impact Distance[d] (km)	Maximum 1-Hour Concentration (mg/m^3)	Impact Distance[d] (km)	Comparison Concentration[e] (mg/m^3)
Volatile organic compounds									
Benzene	40	-	840	0.07	20	-	410	-	150–500 (ERPG)
Cyclohexane	130	-	2,900	-	51	-	1,100	-	3,000–4,000
Ethyl benzene	0.92	-	23	-	0.29	-	7.4	-	500
n-Hexane	200	-	4,200	1.2	51	-	1,100	0.03	500–750
Naphthalene	0.55	-	0.34	-	0.21	-	0.14	-	75–150
n-Octane	44	-	990	-	17	-	360	-	1,500
Styrene	7.7	-	87	-	1.7	-	53	-	200–1,000 (ERPG)
Toluene	32	-	680	-	12	-	260	-	150–1,000 (ERPG)
Xylene	7.7	-	190	-	2.4	-	62	-	600–750
Inorganic compounds									
Hydrogen sulfide	2.4	-	51	0.03	0.61	-	13	-	20–40 (ERPG)

a Maximum and minimum hazards reflect differences in assumed meteorological conditions at the time of the spill. Maximum hazards occur under meteorological conditions of F stability with 1.5 m/s wind speed, whereas minimum hazards occur under D stability with 3 m/s wind speed.

b A leak of 10,000 bbl to the Yukon River resulting from sabotage or vandalism or from corrosion-related damage. For both maximum and minimum hazard scenarios, the surface area of the spill would be about 1,800 acres. Maximum concentration locations are at boundary of spill area but are chemical specific (see Section 4.4.4.6).

c A spill of 21,246 bbl to the Yukon River resulting from a guillotine break. For both maximum and minimum hazard scenarios, the surface area of the spill would be about 840 acres. Maximum concentration locations are at boundary of spill area but are chemical specific (see Section 4.4.4.6).

Footnotes continued on next page.

TABLE 4.4-32 (Cont.)

d Impact distance is the distance from the boundary of the spill area to the location where the ambient air concentration drops below the ERPG-2 or TEEL-2 value.

e The range is from Emergency Response Planning Guideline 1 (ERPG-1) to ERPG-2 where ERPG values are available (EPA 2001c). Otherwise, Temporary Emergency Exposure Limit 1 (TEEL-1) and TEEL-2 values were used. ERPG and TEEL definitions are almost identical, except ERPGs are for 1-hour exposures while TEELs are for 15-minute exposures. Definitions: ERPG-1 (TEEL-1) = the maximum concentration in air below which it is believed nearly all individuals could be exposed for up to 1 hour (up to 15 minutes) without experiencing other than mild transient adverse health effects or perceiving a clearly defined objectionable odor. ERPG-2 (TEEL-2) = the maximum concentration in air below which it is believed nearly all individuals could be exposed for up to 1 hour (up to 15 minutes) without experiencing or developing irreversible or other serious health effects or symptoms that could impair their abilities to take protective action. It is recommended that for application of TEELs, concentration at the receptor point of interest be calculated as the peak 15-minute time-weighted average concentration. Therefore, the comparison with TEELs may be underprotective.

f A dash indicates predicted concentrations are lower than the ERPG-2 or TEEL-2 comparison levels over the entire modeling domain.

Spills of Hazardous Materials Stored or Transported. Approximately 50 different hazardous materials are stored in association with TAPS activities, including drag reducing agent, fire-fighting foams, lubricating oils, and solvents. Under EPCRA, the TAPS Owners are required to submit an annual report of the quantities stored and their storage locations (see Appendix C). To address the possible adverse health outcomes of spills of these stored materials, a screening assessment was conducted to evaluate the toxicity and quantity stored of each. Chemicals with low toxicity (i.e., TEEL-1 values > 50mg/m^3) or low single-container storage volumes (i.e., less than 10 gal per container) were assumed not to present a significant risk from accidental spills. After screening out chemicals with low toxicity or storage volumes, only six substances remained in the hazardous materials storage inventory for further assessment: ethanolamine (a component of citrikleen, up to 900 lb stored at Anchorage Operations Support Facility), ethylene glycol (up to 280,000 lb stored at the Valdez Marine Terminal), fluoroprotein foam (up to 496,000 lb stored at the Valdez Marine Terminal), lubricating oils (up to 80,000 lb stored at pump stations and the Valdez Marine Terminal), sodium hydroxide (up to 159,000 lb stored at the Valdez Marine Terminal), and sulfuric acid (up to 53,000 lb stored at the Valdez Marine Terminal).

Although these substances are stored in large quantities at one or more TAPS facilities, these substances do not represent a large risk from accidental spills. This is because none of the substances are very volatile, so inhalation exposures would be minimal after a spill. In fact, none of the substances are present in the database for the ALOHA model (EPA and NOAA 1999), which is commonly used to assess the impacts of accident releases of chemicals. Therefore, it is concluded that the accidental spill of hazardous materials used in association with TAPS operations would not represent a potential adverse human health impact.

4.4.4.7.3 Health Impacts from Fires. As discussed in Section 4.4.3, impacts from two fire scenarios were assessed: an aircraft crash into the pipeline at MP 456 resulting in a release of up to 41,101 bbl of oil, and an aircraft crash into a storage tank at the Valdez Marine Terminal, releasing 382,500 bbl of crude oil (average working level of tank #2 in East Tank Farm, see discussion in Section 4.4.3). Emissions of particulate matter (soot), PAHs, carbon monoxide, carbon dioxide, nitrogen dioxide (as NO_x), and sulfur dioxide from these fires are assessed. Two assessments are provided, an estimation of the ambient levels of these pollutants at locations near the fire (near-field impacts out to about 3 km from the fire), and an estimation of concentrations at more distant locations (ranging from about 3 to 50 km from the fire), because the high temperature of a fire contributes to plume buoyancy that can transport contaminants for long distances. Large fires are expected to have higher far-field impacts, because the high temperatures contribute to plume buoyancy. Smaller fires generally have higher near-field impacts.

The FDS model was used to assess the near-field air quality impacts, and the FDS results were also used in the FIREPLUME model to assess the far-field air quality impacts. For the far-field modeling, two or more meteorological conditions were modeled in order to estimate the complete range of possible impacts. Details on the modeling assumptions are provided in Section 4.4.3.

Near-Field Impacts. The near-field modeling resulted in estimates of the maximum 15-minutes average concentrations at various receptor locations around the fires at Fairbanks and the Valdez Marine Terminal. The estimated concentrations are compared with ERPG and TEEL values in Table 4.4-33 (see Section 4.4.4.7.2 for discussion of the ERPG and TEEL values). For the Fairbanks fire, the nearest modeled location at 150 m from the fire had the highest concentrations of the contaminants. The modeled concentrations indicate that the SO_2 concentration could exceed the comparison concentration for serious adverse effects at 0.2 km from the fire; the impact distance (distance from the fire to which the concentration equals or exceeds the ERPG-2 value) is between 0.2 and 0.3 km (0.13 and 0.19 mi) from the fire. PM_{10} concentrations could exceed the comparison level for mild adverse effects out to 0.25 km (0.16 mi) from the fire.

TABLE 4.4-33 Near-Field Impacts of Crude Oil Spills with Associated Fire

	Maximum 15-min Concentration (mg/m^3)		
Pollutant	Very Unlikely Pipeline Scenario[a] (53,000 bbl)	Very Unlikely Valdez Marine Terminal Scenario[b] (510,000 bbl)	Comparison Concentration[c] (mg/m^3)
PM_{10}	54	4.2	30–50
PAH	0.04	0.0031	0.6–1
CO	12	0.93	200–400 (ERPG)
CO_2	1,100	49	50,000–75,000
NO_2	0.40	0.031	7.5–35
SO_2	9.9	0.76	0.75–7.5 (ERPG)

[a] Guillotine break resulting from aircraft crash with subsequent fire at MP 449, assuming 2.1×10^6 bbl/d throughput, and near-field concentrations modeled at receptor locations ranging from 150 m to 3 km, highest concentrations are at 200 m from the fire and are given in this table.

[b] Catastrophic storage tank rupture at Valdez Marine Terminal resulting from aircraft crash with subsequent fire, ignition of 510,000 bbl crude oil, near-field concentrations modeled at receptor locations ranging from 196 m to 3 km. Highest concentrations are those closest to fire and are given in this table.

[c] The range is from Emergency Response Planning Guideline 1 (ERPG-1) to ERPG-2 where ERPG values are available (EPA 2001c). Otherwise, Temporary Emergency Exposure Limit 1 (TEEL-1) and TEEL-2 values were used. ERPG and TEEL definitions are almost identical, except ERPGs are for 1-hour exposures while TEELs are for 15-minute exposures. Definitions: ERPG-1 (TEEL-1) = the maximum concentration in air below which it is believed nearly all individuals could be exposed for up to 1 hour (up to 15 minutes) without experiencing other than mild transient adverse health effects or perceiving a clearly defined objectionable odor. ERPG-2 (TEEL-2) = the maximum concentration in air below which it is believed nearly all individuals could be exposed for up to 1 hour (up to 15 minutes) without experiencing or developing irreversible or other serious health effects or symptoms that could impair their abilities to take protective action. It is recommended that for application of TEELs, concentration at the receptor point of interest be calculated as the peak 15-minute time-weighted average concentration. Comparison of estimated maximum 15-minute concentrations with ERPG values is protective.

Table 4.4-33 also shows the near-field modeling results for the Valdez Marine Terminal fire. The nearest modeled location (containment edge #4, 0.2 km [0.1 mi] from the fire) had the highest concentrations of the contaminants. The only contaminant that exceeded a comparison value was sulfur dioxide, with a concentration of 0.76 mg/m^3 at 0.2 km (0.1 mi) from the fire in comparison with an ERPG-1 value of 0.75 mg/m^3. At the next nearest Valdez Marine Terminal receptor location located 0.34 km (0.21 mi) from the fire (the E Manifold Receiving Building), the SO_2 concentration would be decreased to 0.27 mg/m^3. Since no concentrations would exceed ERPG-2 or TEEL-2 values, no serious adverse impacts would be expected for personnel at the Valdez Marine Terminal, although individuals within about 0.3 km (0.2 mi) of the fire and without respiratory protection could experience mild, transient effects.

Far-Field Impacts*.* To assess the far-field impacts, the 30-minute average concentrations of emitted substances were estimated for the Fairbanks pipeline fire, because the fire was estimated to last for 30 minutes. For the Valdez Marine Terminal far-field impacts, the 8-hour average concentrations of emitted substances were estimated, corresponding to the duration of that fire. Various comparison levels were used to evaluate these far-field concentrations, depending on the length of the fire (and therefore, the length of exposure) that was being assessed. For the Fairbanks fire the 30-minute averages were compared with ERPG and TEEL levels, which are appropriate for evaluating short-term exposures. For the Valdez Marine Terminal fire, the 8-hour averages were compared with short-term NAAQS (when available) and with 8-hour time-weighted average threshold limit values (TLVs) (ACGIH 2000). Although TLVs are guideline values for routine 40-hour per week occupational exposures and are not generally applicable to short-term exposures of the general public, they are used here for comparison purposes only. Far-field impacts are given in Table 4.4-34.

For far-field impacts, no comparison values were exceeded for the Fairbanks fire. For the Valdez Marine Terminal fire, the only comparison value that would be exceeded would be the 24-hour NAAQS level for PM_{10}. This exceedance would likely be a regulatory concern, but not a health hazard for a single 8-hour PM_{10} exposure (note that allowable levels for chronic occupational exposures are well above the modeled value).

4.4.4.7.4 Impacts from Foodchain Exposures Resulting from Spills to Water. Many of the assessments of impacts from potential spills in this DEIS are based on projected spill volumes and locations, as detailed in Section 4.4.1.1. However, much information on potential risks from foodchain pathways can be obtained from measured edible tissue contaminant levels in seafood and other species obtained from areas impacted by the Exxon Valdez oil spill in March 1989. The volume of this spill was very large (about 11 million gal, or 260,000 bbl), and many subsequent measures have been taken to ensure that such a large spill would not occur again. Therefore, it can be assumed that in general, the foodchain impacts estimated on the basis of tissue contamination levels associated with the Exxon Valdez oil spill would bound the impacts from any future spills into Prince William Sound during the renewal period. Foodchain impacts from potential spills into rivers along the pipeline will be discussed at the end of this section.

In response to the March 1989 Exxon Valdez oil spill in Prince William Sound, the Alaska Oil Spill Health Task Force (OSHTF) was formed to evaluate the potential health impacts from exposure to the spilled oil (Field et al. 1999). Part of the work of the OSHTF included an extensive study of the degree of oil contamination in subsistence resources contaminated by the spill. This work was conducted by the NOAA's Northwest and Alaska Fisheries Center. The OSHTF also included toxicologists from the U.S. Food and Drug Administration (FDA). Their role was to conduct a health risk assessment addressing the subsistence diet of many Alaska Natives by using the data on fish, shellfish, and marine mammals obtained by the NOAA.

The boundary of the watershed area affected by the Exxon Valdez oil spill is shown in Figure 4.4-3. Between 1989 and 1991, NOAA

TABLE 4.4-34 Far-Field Impacts of Crude Oil Spills with Associated Fire

	Very Unlikely Pipeline Scenario[a] (53,000 bbl)		Very Unlikely Valdez Marine Terminal Scenario[b] (510,000 bbl)	
Pollutant	Maximum 30-min Average Concentration (mg/m^3)	Comparison Concentrations – TEELs and ERPGs[c] (mg/m^3)	Maximum 8-h Average Concentration (mg/m^3)	Comparison Concentrations – NAAQS and TLVs[d] (mg/m^3)
PM_{10}	0.555	30–50	0.52	0.15 (3–10)
PAH	0.0004	0.6–1	0.0004	(0.2)
CO	0.12	200–400 (ERPG)	0.12	10–40 (29)
CO_2	11	50,000–75,000	11	(9,800)
NO_2	0.004	7.5–35	0.004	0.09 (5.6)
SO_2	0.10	0.75–7.5 (ERPG)	0.096	0.37 (5.2)

[a] Guillotine break resulting from aircraft crash with subsequent fire, at MP 449 assuming 2.1×10^6 bbl/d throughput, concentrations modeled at maximum concentration location (38 km, or 24 mi downwind). Assumes D2 stability meteorological conditions; other meteorological conditions resulted in estimated concentrations a factor of 5 or more lower than those presented.

[b] Catastrophic storage tank rupture at Valdez Marine Terminal resulting from aircraft crash with subsequent fire, ignition of 510,000 bbl crude oil, far-field concentrations modeled at maximum concentration location (31 km, or 19 mi downwind). Assumes C/D stability meteorological conditions, for which concentrations were about twice those estimated when assuming D stability.

[c] The range is from Emergency Response Planning Guideline 1 (ERPG-1) to ERPG-2 where ERPG values are available (EPA 2001c). Otherwise, Temporary Emergency Exposure Limit 1 (TEEL-1) and TEEL-2 values were used. ERPG and TEEL definitions are almost identical, except ERPGs are for 1-hour exposures while TEELs are for 15-minute exposures. Definitions: ERPG-1 (TEEL-1) = the maximum concentration in air below which it is believed nearly all individuals could be exposed for up to 1 hour (up to 15 minutes) without experiencing other than mild transient adverse health effects or perceiving a clearly defined objectionable odor. ERPG-2 (TEEL-2) = the maximum concentration in air below which it is believed nearly all individuals could be exposed for up to 1 hour (up to 15 minutes) without experiencing or developing irreversible or other serious health effects or symptoms that could impair their abilities to take protective action. It is recommended that for application of TEELs, concentration at the receptor point of interest be calculated as the peak fifteen-minute time-weighted average concentration. Comparison of estimated maximum 15-minute concentrations with ERPG values is protective.

[d] For PM_{10}, CO, and SO_2, the NAAQS are for short time periods of 8 to 24 hours and are not to be exceeded more than once per year. For PM_{10}, 0.15 mg/m^3 is the 24-hour average limit; for CO, 10 mg/m^3 is the 8-hour average, 40 mg/m^3 is the 1-hour average; and for SO_2, 0.37 mg/m^3 is the 24-hour average. For NO_2, 0.09 mg/m^3 is the annual average limit. Values in parentheses are 8-hour time-weighted average threshold limit values (ACGIH 2000).

staff collected about 258 finfish muscle tissue samples, 1,100 shellfish samples, and samples of blubber, liver, and muscle from about 40 marine mammals (seals and sea lions) from this area. The samples were analyzed for approximately 20 aromatic compounds, mostly PAHs. PAHs are the constituent of crude oil generally of most concern with respect to food chain impacts from oil spills (Bolger and Carrington 1999). PAHs are also formed during the incomplete combustion of coal, oil, gas, wood, garbage, or other organic substances, and are present in tobacco smoke and charbroiled meat; thus people are exposed to this class of compounds through many sources. There are more than 100 different PAHs. They generally occur as complex mixtures (e.g., as soot), not as single compounds. The adverse health effect most associated with exposure to PAHs is increased cancer risk. About ten individual PAH compounds have been identified as carcinogens by various U.S. and international health agencies. Although other adverse health effects can be caused by PAH exposures (e.g., reproductive and immune system effects), these other effects generally do not occur at environmental exposure levels. Therefore, protecting an exposed population from unacceptable increased cancer risk is protective for all adverse effects.

Shellfish (e.g., mussels, chitons, and clams) were the primary focus of the NOAA sampling effort, because it was known that fish and mammalian species have the ability to rapidly metabolize and excrete aromatic contaminants. As expected, the laboratory data showed that finfish and marine mammals rapidly metabolize PAHs to polar compounds that are excreted in the bile, and, therefore, PAH levels in edible muscle and blubber tissues were very low, even in specimens that had been exposed to high levels of contamination. The FDA health risk assessment based on the subsistence specimens collected concluded the following: (1) the risk associated with the consumption of salmon or other finfish that are not smoked is insignificant relative to that associated with consuming smoked salmon, because the process of smoking significantly increases PAH levels, and (2) the increased cancer risk from consumption of unsmoked salmon, other finfish, crustaceans, and oil-contaminated shellfish is low (FDA 1990). The upper-bound lifetime cancer risk for an individual ingesting shellfish reported in the FDA assessment was 2×10^{-6}; this was compared with a risk of 2×10^{-4} for ingestion of smoked salmon.

Updated Foodchain Risk Assessment*.* Primarily because some toxicity evaluation factors for PAHs have changed since the time of the FDA assessment of the Exxon Valdez oil spill impacts, additional risk calculations were conducted to support the foodchain health risk evaluation presented here. Risk calculations were conducted for ingestion of shellfish, but not for finfish or mammalian species, because the data discussed above were sufficient to conclude that risk from ingestion of these species would be negligible (Hom et al. 1999).

The results of the risk assessment for shellfish ingestion are summarized in Table 4.4-35. The assumed rate of shellfish ingestion (i.e., average of 30 g/d [0.5 lb per week] by a 60-kg individual), is the maximum from two surveys of consumption patterns among isolated Alaska Natives in the village of Chenega Bay and on Kodiak Island (FDA 1990). Most of the shellfish eaten by these populations are butter clams, only about 2 g/d are mussels (butter clams showed lower levels of PAH contamination in the NOAA studies, see below).

Two data sets were used for the assessment, each from NOAA analyses in association with the OSHTF (Varanasi et al. 1993). One was the data for mussels collected at Windy Bay in July 1989. The three samples collected from that location contained the highest levels from among the 13 subsistence use areas investigated as a result of the Exxon Valdez oil spill. Levels in mussel tissue collected at Windy Bay were considerably higher than levels in chiton or snail, so the averages for the three mussel samples were used to bound the ingestion concentrations. The second data set was for nine mussel samples collected at Windy Bay in April 1991. The PAH levels observed in these samples were much lower than those collected immediately after the oil spill, in fact, many of the PAH compounds were not detected in these samples. Consequently, the maximum

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FIGURE 4.4-3 Boundary of the Watershed Area Affected by the Exxon Valdez Oil Spill

TABLE 4.4-35 Foodchain Risk from Ingestion of PAH-Contaminated Shellfish Compared with Risk from Ingestion of Smoked Salmon

Scenario	PAH-Associated Risk[a]
Ingestion of highly contaminated shellfish for 10 years[b]	1×10^{-5}
Ingestion of moderately contaminated shellfish for a lifetime (70 years)[c]	3×10^{-7}
Ingestion of highly contaminated shellfish for 10 years – FDA 1990 estimate[d]	2×10^{-6}
Ingestion of smoked salmon for 10 to 70 years[e]	$2 \times 10^{-5} – 2 \times 10^{-4}$

a PAHs measured in shellfish and included in the quantitative risk assessment (toxic equivalency factors [TEFs] used in parentheses) were: benzo[a]pyrene (1), dibenz[a,h]anthracene (5), benzo[a]anthracene (0.1), benzo[b]fluoranthene (0.1), benzo[k]fluoranthene (0.1), indeno[1,2,3-cd]pyrene (0.1), benzo[g,h,I]perylene (0.01), chrysene (0.01), acenaphthene (0.001), acenaphthylene (0.001), fluoranthene (0.001), fluorene (0.001), naphthalene (0.001), phenanthrene (0.001), and pyrene (0.001).

b Contaminant levels are average of three samples obtained in July 1989 from most highly contaminated fishing grounds (Windy Bay 1).

c Contaminant levels are maximums from nine samples obtained in April 1991 (Windy Bay 1).

d Contaminant levels from most highly contaminated fishing grounds; different slope factor and TEFs applied in risk calculation account for this risk estimate being smaller than that calculated in this study.

e Contaminant levels are averages of four salmon samples obtained from Tatitlek and Old Harbor in October 1989 that were subsequently smoked. The lower end of the range is for 10 years of exposure; the upper end is for a lifetime of 70 years.

level (not the average) of each PAH compound detected was used in evaluating the 1991 data. The sum of the 15 PAHs for the 1989 data set was 160 ppb; the sum of the PAHs for the 1991 data set was 2 ppb. The combination of shellfish tissue contamination data and average ingestion rate was used to estimate the average daily intake of 15 PAHs for Alaska Natives on a subsistence diet.

To bound the risk from ingestion, it was assumed that the more highly contaminated shellfish could be ingested for up to 10 years. This time period was used to allow comparison with the FDA results, which were reported above. However, the 1991 data showed that contamination levels declined significantly within just 2 years; thus, 10 years of exposure at the elevated levels would be unlikely. An assessment of the risks from ingestion of the moderately contaminated shellfish (1991 data) over a lifetime of 70 years was also included. It was considered reasonable to include a prolonged possible exposure period because the PAH compounds are relatively persistent, and significant oil contamination was still found in some mussel beds 10 years after the Exxon Valdez oil spill (Fall 1999b).

Benzo[a]pyrene is the PAH with the most toxicity data available to use as a basis for developing quantitative estimates of cancer risk. An ingestion slope factor of 7.3 $(mg/kg\text{-}d)^{-1}$ for benzo[a]pyrene has been developed by the EPA (2001c). (See Section 3.17.2.3 to review the use of slope factors in estimating increased cancer risks.) This slope factor value is higher than the value of 1.75 $(mg/kg\text{-}d)^{-1}$ used by the FDA in its assessment (Bolger et al. 1996) and would result in higher risk estimates. An approach for estimating the cancer-causing potential of complex mixtures of PAHs based on “toxic equivalency factors” (TEFs) of specific PAHs relative to benzo[a]pyrene is recommended by the EPA (1993) and has been applied in this assessment of risk from ingestion for subsistence diets. The TEFs used are those reported by Nisbet and LaGoy (1992); these values also differed somewhat from those used in the FDA assessment (Bolger et al. 1996) and were specifically more conservative (i.e., resulted in higher risk estimates) for the PAH dibenzo[a,h]anthracene.

On this basis, the bounding estimates of increased lifetime cancer risk associated with 10 years of ingestion of highly contaminated shellfish is 1×10^{-5}, the increased risk from an additional 70 years of ingestion of moderately contaminated shellfish is 3×10^{-7}, for a total lifetime increased risk of about 1×10^{-5}. This risk is within the 10^{-6} to 10^{-4} tolerable risk range specified by the EPA (1990).

For additional perspective, the increased cancer risk can be compared with that from eating smoked salmon. The NOAA study used for shellfish contamination levels also included analyses of four smoked salmon samples from two of the Alaska Native villages. These samples contained an average of 8,700 ppb total carcinogenic PAHs in edible tissue (Varanasi et al. 1993). Assuming 10 to 70 years of salmon ingestion at about 45 g/d (0.7 lb/wk) (Bolger et al. 1996), the increased cancer risk from smoked salmon ingestion alone would range from 2×10^{-5} to 2×10^{-4}. Clearly, extended ingestion of smoked fish would be as great or greater a source of risk as ingestion of contaminated shellfish. The lower end of the range is about the same as the risk reported above for ingestion of contaminated shellfish.

As in any quantitative risk assessment, there are several gaps in the toxicological database that result in uncertainties in the assessment results. First and foremost, the quantification of risk included only 15 PAHs, although crude oil contains about 100 different PAHs, and other potentially toxic substances (e.g., dibenzothiophenes, trace metals). The toxicological response to exposure to these types of mixtures is much more difficult to predict that the response to a single chemical exposure. Studies show an imperfect correlation between PAH content and the degree of carcinogenicity in various petroleum fractions, suggesting that the cancer-causing potential of some crude oil constituents has not yet been identified (Bolger and Carrington 1999).

A class of compounds present in crude oils and of particular interest is organosulfur compounds, especially condensed thiophenes, which are structurally similar to the carcinogenic PAHs but contain a sulfur atom in the ring structure. Some of these compounds have been found to be mutagenic, with potencies similar to that of benzo[a]pyrene (Kropp and Fedorak 1998). The NOAA shellfish samples used in this risk assessment were also analyzed for dibenzothiophene and alkylated dibenzothiophenes. In the Windy Bay 1 PAH-contaminated samples assessed, these thiophenes constituted about one-third of the concentration of low molecular weight aromatic carbons detected. To date, dibenzothiophene has not been shown to be mutagenic. However, the analyses for condensed thiophenes were quite limited, so some with mutagenic activity may also have been present. If these mutagenic compounds were present in the edible tissues, it would mean that the carcinogenic risk for ingestion of the shellfish was underestimated. To address this data gap, the mutagenic condensed thiophenes would need to be included in tissue sample analyses, and more complete investigation of their potencies relative to benzo[a]pyrene would be needed.

It is of interest to note that the rate of stomach cancer among Alaska Natives is three times higher than that of the U.S. White population (Lanier et al. 2000). Stomach cancer would be the type of cancer most likely to be elevated in association with ingestion of carcinogenic PAHs. The cause of the increased stomach cancer incidence among Alaska Natives is not known but perhaps is associated with frequent ingestion of smoked foods. With the increased rate of stomach cancer in this population, any additional exposures to PAHs should be avoided where possible. With this in mind, it is fortunate that, in general, after an oil spill the most highly contaminated shellfish beds can be visually identified and avoided, thus minimizing the likelihood of prolonged PAH exposure through the foodchain.

An oil spill could also occur into one of the many rivers crossed by the pipeline. The potential impacts of spills to rivers are discussed in Section 4.4.4.7.2. A spill would have adverse impacts on fish species used for food by Alaska Natives for a period of time. Fish passing through the contaminated area would be oiled and not suitable for ingestion. However, it is believed that because of the rapid metabolism and excretion of PAH compounds by fish, once the spill was contained and cleaned up to the extent practicable, the muscle tissue of fish that were not noticeably contaminated (e.g., visible oil on surface, odor of contamination) would be edible, and ingestion would not present an increased cancer risk.

4.4.4.8 Biological Resources Overview

The direct and indirect impacts of spills on biological resources are discussed in the sections that follow (through Section 4.4.4.12). The impacts on biological resources of spills would vary according to the material spilled, volume of the spill, and the location of the spill. Spills could contaminate soils, surface water, and groundwater and affect biological resources associated with these media. For the most part, spills that are anticipated or likely to occur would be small and affect only areas within the existing ROW or facility areas. The largest potential catastrophic spill to land (resulting from a guillotine break in the pipeline) would affect about 84 acres. If such a spill occurred at one of the rivers crossed by the TAPS, a considerable length of the river downstream of the spill site could be affected. The area affected would depend on river flow at the time of the spill and cleanup response time. The largest spill at the Valdez Marine Terminal could affect about 2 mi of shoreline and up to about 2 mi^2 in Port Valdez.

The impacts of a large spill to land would be expected to have localized effects on vegetation communities; bird and mammal populations; and threatened, endangered, and protected species populations, but would not noticeably affect regional vegetation patterns or animal populations. Such a spill could have localized effects on fish populations in adjacent water bodies. Containment and cleanup of a land spill are expected to be rapid and effective and would substantially reduce the magnitude and duration of impact.

A large spill to water (either at one of the rivers crossed by the TAPS or at Port Valdez) could have more widespread effects on biological resources. Unless quickly contained, a large spill to a river could affect a large portion of the river's fish population, much of the shoreline riparian vegetation, and riverine wildlife (e.g., waterfowl, river otters). Listed and protected species would not be affected by a river spill. A large spill to Port Valdez could affect shoreline vegetation, fish communities, and a number of listed and protected species (a variety of marine mammals) that occur in Port Valdez. The magnitude and duration of the impact would depend on the ability to contain and remove spilled oil.

4.4.4.9 Terrestrial Vegetation and Wetlands

Operation of the TAPS may result in accidental spills of oil or other materials over the course of the renewal period. Such spills could contaminate soils, surface water, and groundwater in the vicinity. Depending on the volume of the spill and time of year, vegetation could be injured or killed, and its reestablishment may be impeded or delayed because of residual soil contamination. Small spills onto level soil surfaces of the ROW that are immediately cleaned up would likely have minimal impacts other than the removal of vegetation in the immediate vicinity of the spill. After being cleaned up, these areas can be

Impact of Oil Spills on Vegetation and Wetlands

Small spills, such as those that might be anticipated during the renewal period, would impact a relatively small area and would not be expected to have long-term impacts to terrestrial vegetation and wetlands. Large spills would be unlikely, but if they did occur, might have long-term effects on terrestrial vegetation and wetlands.

backfilled, regraded, and revegetated. Depending on the source, soils used for backfilling may contain seeds or other propagules of plant species that are not native to the area of the spill and may, therefore, provide an opportunity for introduction of exotic species.

Spilled fluids that are not immediately cleaned up may migrate to lower soil strata and groundwater. The presence of oil on the ground surface may result in the development of thermokarst, as ice-rich shallow permafrost becomes warmed and thaws. Thermokarst may also result from soil exposure following removal of vegetation and the surface organic mat during cleanup activities. Areas of some vegetation communities may be eliminated as areas of thermokarst subsequently become inundated.

Some vegetation may survive low levels of oil contamination, or recolonize oil-damaged soils following applications of fertilizer (McKendrick 1987; McKendrick and Mitchell 1978a,b). Vegetation communities on drier soils may be more sensitive to the effects of oil than communities on wet or saturated soils (Walker et al. 1978), while some species such as willows or sedges (Walker et al. 1978) or cottongrass (Collins et al. 1994), may be less sensitive.

Spills of diesel fuel tend to have a greater effect on vegetation than crude oil. Vegetation that comes in contact with diesel fuel is killed, even on wet soils (Walker et al. 1978). Submerged wetland vegetation is less affected by either crude oil or diesel fuel, and has the greatest potential for recovery after a spill. Most areas receiving spilled oil, however, would remain poorly vegetated or unvegetated for many years if the oil contamination was not remediated or efforts were not undertaken to restore vegetation (Collins et al. 1994; McKendrick 1987; McKendrick and Mitchell 1978a,b; Mitchell et al. 1979). Spills onto frozen ground during winter generally have a low degree of soil penetration (McKendrick and Mitchell 1978b, Collins et al. 1994). The limited soil infiltration by the spilled material and dormancy of plants generally result in lesser effects from winter spills that are remediated quickly (McKendrick and Mitchell 1978b), although oil remaining on the surface can have severe effects (Collins et al. 1994). It is expected that remediation of spill areas would include the removal of vegetation and contaminated soils. These areas would be backfilled with clean soil and revegetated. Reestablishment of natural communities in these areas may be difficult and require extended periods of time if soil types used for restoration are different than the original soils. Restoration efforts would evaluated by the AO and SPC, and methods would be designated on a site-specific basis to reestablish natural communities in affected areas.

A number of scenarios were developed to analyze potential impacts from oil spills for the proposed action (see Section 4.4.1). The analysis of impacts to vegetation evaluated pipeline leaks or breaks resulting in overland flow of oil, breaks occurring near elevated river crossings, and spills and breaks at the Valdez Marine Terminal. The relative frequencies of occurrence of spills and breaks were designated as *anticipated* (occurring more often than 0.5/yr), *likely* (0.03 to 0.5/yr), *unlikely* (1×10^{-3} to 0.03/yr), or *very unlikely* (1×10^{-6} to 1×10^{-3}/yr). The spill scenarios discussed below were selected for analysis because they would have the greatest potential impacts within their frequency range.

An example of an *anticipated* spill would be a small leak of diesel fuel during pipeline operations, resulting in up to 100 bbl of diesel fuel being spilled (Scenario 2, Table 4.4-1). If spread evenly over the landscape at a thickness of 1 in., the diesel fuel could cover an area of up to about 0.2 acre. A spill occurring in winter might cover a larger area than a similar spill during summer (Collins et al. 1993). Uneven ground surfaces, penetration of oil into the soil, and intervening vegetation and debris might restrict the spread of the spilled oil and result in a smaller area covered at a greater thickness or depth. An area of about 0.05 acre would be covered by a 3-in.-deep spill.

A spill from a pipeline leak caused by vandalism would be designated as *likely* (Scenario 12, Table 4.4-1). From 900 to 10,000 bbl of crude oil might be spilled in such an event. The spill would cover 1.4 to 15 acres at a depth of 1 in. and 0.5 to 5 acres if the depth was 3 in.

A spill caused by a guillotine break as the result of a crash of fixed-wing aircraft into the pipeline would be considered an *unlikely* event (Scenario 19a, Table 4.4-1). Under this scenario, from 2,000 up to about 54,000 bbl of crude oil would be spilled. The spilled oil would potentially cover an area of 3 to 84 acres at 1 in. depth, or an area of 1 to 28 acres if the spilled oil was 3 in. deep. A scenario considered *very unlikely* would be a guillotine break of the pipeline caused by the impact of a helicopter (Scenario 21, Table 4.4-1). The volume of crude oil spilled and the area covered would be the same as for the fixed-wing aircraft crash scenario. Although, the volume of a spill and the area covered might be less at any given location than that postulated under Scenarios 19a and 21, that volume and area represent a worst case, or bounding analysis, for evaluation of maximum impacts to terrestrial vegetation or wetlands along the ROW from a spill.

As noted above, various factors would influence the extent of impacts to terrestrial vegetation and wetlands in the event of a spill or pipeline break. The impacts of the spills evaluated for the various scenarios would depend on site-specific factors at the location and at the time of the spill, such as the material spilled, the intensity of the spill (lightly or heavily oiled ground), season, soil moisture level, degree of soil infiltration, and type and amount of vegetation present. However, any vegetation affected by a spill under any of these scenarios would generally be expected to be injured or killed, with lower survival of vegetation from a diesel fuel spill than from an oil spill.

Under the worst-case scenarios (Scenarios 19a, and 21, Table 4.4-1) in an area of lowland tundra, up to 84 acres of tundra could be impacted by a crude oil spill. Impacted vegetation communities would likely be primarily previously undisturbed wet sedge meadow communities, which are abundant on the Arctic Coastal Plain in the vicinity of the TAPS. Effects of oil contamination and remediation of the impacted soils would result in the elimination of these communities from the affected areas. Although revegetation efforts would be expected to eventually successfully establish native lowland tundra vegetation cover (McKendrick 1987, 1997; McKendrick and Mitchell 1978a), a number of years might be required for natural community development. The diversity of community types present in undisturbed lowland tundra may be absent or reduced in remediated areas.

A crude oil spill onto upland tundra might also impact up to 84 acres of previously undisturbed vegetation communities. The vegetation types affected might include tussock tundra communities, primarily in the northern foothills of the Brooks Range, or dwarf shrub tundra and low shrub tundra in alpine areas of the Brooks Range, Alaska Range, or Coastal Mountains. Reestablishment of these native communities might be difficult on steep slopes, and a number of years might be required for community development.

A worst-case spill in an undisturbed boreal forest area might impact up to 84 acres of forest communities, including white spruce forest and black spruce forest. Reestablishment of these forest communities might require substantial periods of time, particularly in areas where underlying permafrost was affected by the spill (Collins et al. 1994) or where natural soil was removed in cleanup efforts. Tall shrub and deciduous forest communities might become the dominant vegetation types on remediated sites before reestablishment of spruce forest communities.

A crude oil spill in a coastal forest might also impact up to 84 acres of previously undisturbed communities, primarily western hemlock-Sitka spruce forest. Reestablishment of these forest communities might also require substantial periods of time. As in the boreal forest area, tall shrub and deciduous forest communities might become the dominant vegetation types on remediated sites prior to reestablishment of hemlock-spruce forest communities.

Crude oil spilled into a river or stream would be transported downstream and would be subject to mixing and emulsification in the water and attachment to bottom sediments (Section 4.4.4.3). Oil in sediments might be transported downstream over time and cause continuing long-term contamination of downstream areas. Spilled oil would also be deposited along the shoreline, where it might penetrate sands and gravels, potentially reaching lower layers of substrate. Deposited oil might later reenter the stream current and become a source of future contamination. Depending on conditions at the time of the spill, vegetation along the impacted streams might become covered with oil and may be injured or killed by direct contact or by contamination of soil and water. Reestablishment of these vegetation communities might be difficult because of streambank contamination. Losses of riparian vegetation may increase the potential for soil erosion along streambanks, which might also affect the reestablishment of riparian communities.

Spill scenarios were developed for six TAPS river crossings (Section 4.4.4.3) and describe *unlikely* or *very unlikely* spill events involving a guillotine break. Under those scenarios, pipeline breaks could result in direct discharges of crude oil to rivers. The river crossings evaluated were over the Gulkana River, Minton Creek, Dan Creek/Sagavanirktok River, Yukon River, Tazlina River, and Tanana River.

On the Gulkana River, the spilled oil would not be expected to pass the containment area, postulated to be 20 mi downstream of the spill location, and 100% of the oil spilled would be subject to recovery upstream of the containment site. Therefore, the primary effects of the spill would occur along the 20-mi river segment downstream from MP 654. Riparian vegetation along this river segment, including scrub-shrub and forested wetlands, could be killed or injured.

Under high-flow conditions on Minton Creek, from 6 to 87% of the oil would be subject to recovery at the containment site 12 mi downstream of the spill. Although the effects of the spill would be greatest upstream of the containment site, many miles of the downstream areas could become contaminated by oil. Extensive areas of forested and scrub-shrub wetlands, as well as smaller areas of emergent wetlands, could be impacted downstream.

No recovery of oil would be expected from a spill into the Dan Creek/Sagavanirktok River at MP 85, the Yukon River at MP 353, the Tazlina River at MP 686, or the Tanana River at MP 531. Potentially affected wetlands downstream of the spill on these four rivers include scrub-shrub wetlands, as well as emergent wetlands along the Sagavanirktok River, forested wetlands along the Tazlina and Tanana Rivers, and smaller areas of emergent wetland along the Tanana River. Riparian vegetation could be killed or injured for many miles downstream as the oil slick continued to spread and deposit oil on the shorelines. Under low flow conditions, 100% of the oil would be subject to recovery at the containment site on the Sagavanirktok River, Minton Creek, and the Gulkana River, while 0 to 36% of oil released on the Yukon River and 0% on the Tazlina or Tanana Rivers would be recovered (Section 4.4.4.3).

Spill scenarios involving a transportation accident (overturn of a fuel truck) were also developed (Section 4.4.1, Table 4.4-3) and included accidents in the *unlikely* and *very unlikely* frequency range. Under these scenarios, between 119 and 190 bbl of turbine fuel or diesel fuel would be spilled on land. At a thickness of 1 in., the fuel would potentially cover an area of 0.2 to 0.3 acre, or an area of 0.06 to 0.1 acre for a 3-in. deep spill. Most or all terrestrial or wetland vegetation coming in contact with the fuel would be eliminated. Wetland vegetation entirely submerged below the water surface during the spill would likely show the greatest recovery following remediation.

A number of spill scenarios were also developed for Valdez Marine Terminal operations (Section 4.4.1, Table 4.4-2). Spills onto land would likely flow into a creek near the terminal. The creek, in turn, flows into Port Valdez near Berth 4 (Section 4.4.4.5.1). Spills that enter the water of Port Valdez might reach wetlands located along the shoreline. Vegetation along the path of the spill would be injured or killed, including wetland vegetation along the creek and on the Port Valdez shoreline. The largest spill in the *very unlikely* frequency range would be a release of crude oil resulting from a catastrophic rupture of a storage tank (Scenario 11, Table 4.4-2). About 194,000 bbl of crude oil would spill outside the secondary containment, with 143,450 bbl reaching the water of Port Valdez and 50,350 bbl remaining on land. Depending on a number of factors at the time of the spill (such as wind direction), up to about 80% of the oil released to the water might reach the shoreline. Up to 2 mi of shoreline might become heavily oiled, with small amounts of oil potentially reaching other shoreline areas. Oil reaching the shoreline might persist for extended periods of time and slow or reduce vegetation recovery.

4.4.4.10 Fish

The effects of an oil spill on fish primarily depend on the location of the spill relative to the location of fish and their habitat, the type of petroleum (e.g., crude oil vs. refined products) involved, the concentration of oil present, the stage of fish development exposed to the oil (eggs, larvae, and juveniles are most sensitive), and the duration of exposure. Depending on the quantity spilled, oil can affect aquatic organisms in several ways. Physically coating a fish in oil, especially its respiratory surfaces (i.e., gills), can cause immobilization or suffocation. If concentrations of certain chemical constituents of the oil are sufficiently high, exposed fish will die. Lower concentrations may have sublethal effects, such as reduced growth, reduced reproduction, or altered behavior. Elevated concentrations of oil may also indirectly affect fish if impacts of the oil on other organisms reduce the availability of prey for fish. The presence of oil may also cause some fish to avoid areas traditionally used for reproduction, feeding, overwintering, or as migration corridors. In addition, oil spills have the potential to affect commercial, sport, and personal use/subsistence fisheries because fish contaminated with oil pose a potential risk to people who eat them. As a consequence, fisheries in the vicinity of oil spills are often closed until testing shows that fish are no longer contaminated.

Impacts of Oil Spills on Fish

A major spill of oil from TAPS into a waterway as a result of a failure or guillotine break in the pipeline could result in severe effects on fish, depending upon the size of the receiving stream, the nature of fish community in the stream, and the season of the year. Such spills are considered very unlikely to unlikely. Smaller spills would have less effect on fish resources but would have a higher probability of occurrence.

Different types of oil have different characteristics that affect their potential for adverse effects on fish. Fuel oils, such as gasoline and diesel fuel, are very light oils. Light oils are very volatile (i.e., they evaporate relatively quickly), so as they spread on the surface of the water, they usually don't remain in the aquatic environment very long (typically no longer than a few days). However, light oils also tend to be more acutely toxic to organisms than heavier oils. In contrast, very heavy oils (such as bunker oils, which are used to fuel ships) look black and sticky and evaporate slowly. As a consequence, heavier oils can remain in the water for a long time (weeks, months, or even years). While these oils can be very persistent, they are generally considerably less acutely toxic than light oils. Instead, the initial threat from heavy oils comes from their ability to smother organisms by restricting the exchange of oxygen. After days or weeks, some heavy oils will harden. In this hardened state, heavy oils are less likely to harm animals or plants that come in contact with them. North Slope crude oil, such as that transported in the TAPS, falls in between these extremes of light and heavy oils and has toxicity levels between the extremes described above.

This section discusses the potential impacts to fish from scenarios involving potential oil spills from the TAPS. Included in the evaluation are potential impacts from spills that enter freshwater or marine habitats in the vicinity of the TAPS ROW or the Valdez Marine Terminal. The potential volumes of oil released and estimated frequencies of occurrence associated with each of the evaluated spill scenarios are described in Section 4.4.1. Information about the degree to which oil from each spill scenario would be distributed in freshwater and marine habitats is provided in Sections 4.4.4.3 and 4.4.4.5, respectively.

4.4.4.10.1 TAPS ROW. Although it is very difficult to precisely predict the effects of each spill scenario on fish in streams associated with the pipeline, in general, the effects of a crude oil spill from the TAPS would be a function of the amount of oil spilled (relative to stream discharge), the duration of exposure to spilled oil, and the sensitivities of the fish species and life stages present at the time of the spill. Thus, the relative level of adverse impacts for different spill scenarios was inferred on the basis of the volume of oil that would be introduced by a particular scenario, the length of stream habitat that the oil would travel through before containment, the length of time it would take the oil spill to pass through a particular area, the depth of the stream, and the fish resources present. The magnitude of oil spill effects to fish populations in a particular stream would also be related to the degree to which containment was effective at restricting downstream movement and recovering the spilled oil. The effects of an oil spill on freshwater habitats varies according to the rate of water flow and the habitat's specific characteristics. Standing water such as marshes or swamps with little water movement are likely to incur more severe impacts than flowing water because spilled oil tends to pool in the water and can remain there for long periods of time.

The portions of streams potentially affected by spilled oil under various spill scenarios, are identified in Section 4.4.4.3.

Spill scenarios with frequencies of greater than 0.5/year (described in Section 4.4.1 as *anticipated*) include smaller spills with volumes up to about 100 bbl. These scenarios include spills of crude oil, gasoline, turbine fuel, or diesel fuel and would occur over very short periods of time. As reported in Section 4.4.4.3, such a spill could produce a slick up to approximately 300 ft long in rivers such as the Tanana or Tazlina. Because of the smaller size and the short exposure duration as the oil slick passes through a particular reach, it is anticipated that such spills would have less effect on fish than would the larger spills described below unless the spill was into a very small stream. It is considered unlikely that such a spill would block or preclude movement of migrating fish or affect overwintering areas.

As identified in Section 4.4.1, the largest potential spill from a scenario considered *likely* (occurrence frequency of 0.03 to 0.5/year for the entire length of the pipeline) would be Scenarios 12 or 14 (Table 4.4-1). Under these scenarios, up to about 10,000 bbl of crude oil could be released over a prolonged period as a result of corrosion-related damage to the pipeline. A spill of this magnitude would be likely to cause moderate impact to fish in the affected portion if the oil was to enter a relatively small waterway. A spill of about 10,000 bbl of crude oil into the Pine River in British Columbia reportedly resulted in some fish mortality within the oiled area (Reuters World Environment News 2000a,b), although impacts to lower reaches of the river were reduced by containment efforts. However, impacts to streams along the TAPS could be greater if such a spill occurred during a sensitive period, such as migration or spawning, or if it occurred in a smaller stream.

Scenarios considered *unlikely* to *very unlikely* (as defined in Section 4.4.1) would involve a guillotine break in the pipeline caused by the crash of a helicopter or airplane (Scenarios 19a, 19b, and 21; Table 4.4-1). Such events would cause the largest spills to freshwater areas along the TAPS ROW and, presumably, the greatest impacts to fish. Depending on the rate of flow of individual streams and the time needed for spilled oil to drain from the pipeline, it is estimated that the length of oil slicks resulting from guillotine breaks in the pipeline would range from approximately 1 mi in the case of the Tanana River to about 13 mi in the case of the Sagavanirktok River (Table 4.4-15). It is estimated that the leading edge of the resulting oil slicks would travel between 13 and 48 mi downstream of the breaks during the average amount of time needed for oil spill response (Table 4.4-15). On the basis of the analysis provided in Section 4.4.4.3, it appears that containment of oil at designated containment sites will be incomplete or ineffective in some cases because the slick could completely pass by the designated containment sites before containment equipment could be deployed. In such cases, the portion of the stream in which fish could potentially be affected may be considerably longer.

If the assumption is made that the spilled oil would completely mix throughout the water column of the affected stream or river, an estimate of the proportion of oil to water can also be derived. Although this estimate may give some indication of potential concentrations in shallow streams, the ability of such an analysis to estimate concentrations in deeper rivers is limited because of the tendency of oil to float on the water surface. Thus, while oil may become distributed throughout a large proportion of the water depth in small streams (e.g., Minton Creek), only a small potion of the water column is likely to become mixed with oil in deeper streams (e.g., the Yukon River). With these limitations in mind, the estimated proportions of oil to water in the streams for guillotine break spill scenarios were developed by calculating the water volume passing a spill location during the drainage time required for the spill to be completed (Table 4.4-36). These calculations (which are based on the largest of the spill volumes for the three TAPS throughput cases) indicate that under scenarios with guillotine breaks in the pipeline, spilled oil would constitute a large proportion of the total volume in the smaller, shallower streams and somewhat smaller proportions of larger streams and rivers.

It is estimated that a guillotine break in the crossing over Minton Creek would result in 14 times more oil than water in the oil slick area under low-flow conditions and a mixture of 47% oil under high-flow conditions. It is clear that a very large proportion of the aquatic organisms located within the spill zone would be killed under such conditions. If this event occurred during the migration, spawning, or incubation periods for salmon, a whole year's production for the affected stream could be lost, and residual effects of the oil contamination would likely persist for years afterward.

If the oil became thoroughly mixed in the water column, it is estimated that a guillotine break in the pipeline at the river crossing over the Gulkana River would result in a mixture of about 11% oil under low-flow conditions and about 0.6% oil under high-flow conditions in the main slick (up to 1.5 mi long under low-flow and 10.1 mi long under high-flow conditions). As with the Minton Creek scenario, it is estimated that a considerable proportion of the fish in the affected stretch of the stream would be impacted under low-flow conditions. Because the Gulkana River is an important anadromous fish stream and supports a large fishery for both anadromous and resident fish species, such a spill could be especially severe.

In the Yukon River, a similar scenario would result in about 0.05% oil under low-flow conditions and about 0.01% oil under high-flow conditions, with slick lengths of up to 4 to 9 mi under low- and high-flow conditions, respectively. In larger and deeper waterways, such as the Yukon River, most of the oil discharged during a large oil spill would be located on the water surface and many of the fish and bottom-dwelling invertebrates would not be exposed to the oil as it passed over. However, organisms located in shallower shorelines of the affected rivers and eggs or larvae located near the water surface could still be affected by the spilled oil, and some mortality would be expected during an extremely large oil spill.

In contrast, virtually all of the aquatic organisms in the contaminated portions of small streams such as Minton Creek and shallower rivers, such as the Gulkana, would probably be exposed to elevated and potentially lethal concentrations of crude oil in the event of a large break in the pipeline at or near a river crossing. However, as identified in Section 4.4.1, it is considered unlikely or very unlikely that such an event would occur.

This analysis indicates that fish and food resources in the immediate area of a spill could receive lethal or sublethal doses of oil, particularly if a spill occurred where and when fish were migrating, in overwintering areas during winter, or in small water bodies with limited water exchange. If an oil spill of sufficient size occurred in a small water body with restricted exchange, lethal and sublethal effects would be expected for most of the fish and food resources in that water body, and recovery could take several years. Sublethal effects could include changes in growth rates, feeding rates, fecundity, survival rates, and displacement of individuals. Other possible effects could include interference with movements to feeding, overwintering, or spawning areas, in addition to localized reduction in food resources and effects from consumption of contaminated prey.

4.4.4.10.2 Prince William Sound. Although large spills resulting from tanker accidents are not evaluated as part of TAPS operations (they are considered in the cumulative analysis, Section 4.7.4.4), the potential impacts from an unlikely catastrophic rupture of a crude oil storage tank at the Valdez Marine Terminal was evaluated. Under this

TABLE 4.4-36 Estimated Proportions of Oil to Water under High- and Low-Flow Conditions for Hypothetical Guillotine Breaks at Selected River Crossings

Location	Milepost	Oil Spill Drain Time (s)	Volume of Spilled Oil (ft^3)	Low Flow Discharge (ft^3/s)	Low Flow Water Volume (ft^3)	Low Flow Percent Oil in Water	High Flow Discharge (ft^3/s)	High Flow Water Volume (ft^3)	High Flow Percent Oil in Water
Sagavanirktok River	85	1,320	177,758	2,000	2,640,000	6.73	28,000	36,960,000	0.48
Yukon River	353	1,680	119,280	150,000	252,000,000	0.05	800,000	1,344,000,000	0.01
Minton Creek	510	4,260	302,983	5	21,300	1422.46	150	639,000	47.42
Tanana River	531	480	65,192	15,000	7,200,000	0.91	60,000	28,800,000	0.23
Gulkana River	654	2,220	156,805	600	1,332,000	11.77	12,000	26,640,000	0.59
Tazlina River	686	1,440	102,690	2,000	2,880,000	3.57	26,000	37,440,000	0.27

scenario, it is estimated that a maximum of 143,000 bbl of crude oil could reach Port Valdez at the Valdez Marine Terminal (see Section 4.4.1.3.2). Hydrological modeling used to estimate the potential movement of the spilled oil in Prince William Sound indicated that the spilled oil would probably move up to 2 mi before it could be contained (Section 4.4.4.5). The model also indicated that between 44 and 80% of the spilled oil would become beached.

In open water, such as Prince William Sound, fish have the ability to avoid a spill by going deeper in the water or farther out to sea, thereby reducing the likelihood that they will be harmed by even a major spill. Fish that live closer to shore are at risk from oil that washes onto beaches or from consuming oil-contaminated prey. In shallow waters, oil may also harm invertebrates used as food or sea grasses and kelp beds that are used for feeding, shelter, or nesting sites by many different fish species. In addition, the Solomon Gulch Fish Hatchery is located near the Valdez Marine Terminal, and an oil spill in the vicinity could affect adult salmon returning to the hatchery or juvenile salmon leaving Solomon Creek.

There are concerns that oil deposited along the shoreline or that enters small streams in the vicinity of the Valdez Marine Terminal could affect fish populations, especially pink salmon that spawn within the intertidal zone. Following the Exxon Valdez oil spill, extensive field research was conducted along the shorelines and in the streams of Prince William Sound to evaluate whether the spill caused measurable impacts on the health or condition of aquatic organisms. Brannon et al. (1995) found no substantial effects on eggs, fry, or juvenile life stages of pink salmon from 1989-1991. Maki et al. (1995) found no significant relationship between the levels of polynuclear aromatic hydrocarbons and salmon escapement levels from 1989-1992 and were unable to detect significant differences in numbers of returns of spawning adult pink salmon between oiled and unoiled streams over the same period. Other studies (Craig et al. 1995; Bue et al. 1996) reported that there were indications of higher pink salon egg mortality in oiled streams, although it appears that this finding may have been biased by the sampling protocol used (Brannon et al. 2001).

4.4.4.11 Birds and Terrestrial Mammals

The impacts to wildlife from an oil spill would depend on such factors as the time of year and volume of the spill, type and extent of habitat affected, and home range or density of the wildlife species. For example, as the size of a species' home range increases, the effect of the oil spill generally decreases (Irons et al. 2000). Similarly, oil spill impacts are harder to detect for species with low densities. Section 4.4.4.1 provides information for land-based and Port Valdez spills, and Section 4.4.4.3 provides information for potential surface-water spills. The following discussion addresses the potential effects of oil spills on birds and terrestrial mammals. Potential impacts to marine mammals and listed species are addressed in Section 4.4.4.12.

Impacts of Oil Spills on Birds and Terrestrial Mammals

An oil spill would be expected to have a population-level adverse impact only if the spill was very large or contaminated a crucial habitat area where a large number of individual animals were concentrated. The potential for either event to occur is very unlikely. For a comparable oil-spill volume, a water-based spill would be expected to have a more extensive impact to wildlife than a land-based spill, because of the spatial extent of contamination within, and higher degree of difficulty to cleanup, a water spill.

The potential effects to wildlife from oil spills could occur from direct contamination of individual animals, contamination of habitats, and contamination of food resources (ADNR 1999). Acute (short-term) effects usually occur from direct oiling of animals; chronic (long-term) effects generally result from such factors as accumulation of contaminants from food items and environmental media (e.g., water)

(Irons et al. 2000). Moderate to heavy contact with oil is most often fatal to wildlife. In aquatic habitats, death occurs from hypothermia, shock, or drowning. In birds, chronic oil exposure can reduce reproduction, cause pathological conditions, reduce chick growth, and reduce hatching success (MMS 1998). Even small quantities of oil on the surface of a bird egg can kill the embryo (Clark 1984). The reduction or contamination of food resources from an oil spill could also reduce survival and reproductive rates (MMS 1998). Oil ingestion during preening or feeding may impair endocrine and liver functions, reduce breeding success, and reduce growth of offspring (TAPS Owners 2001a).

The susceptibility of birds to an oil spill would depend upon a number of factors, including species and season. For example, some species may be most vulnerable during molt if they are not flight capable. Species that nest in concentrated colonies may be more vulnerable than species that have widely dispersed nests. Wintering concentrations of birds, especially in marine areas, could also be adversely affected if energetic needs are high and food becomes limited because of an oil spill. Oiling of feathers would also increase energetic demands (Anderson 2002). Oil reaching ponds or lakes can have long-term effects on invertebrate prey populations and emergent vegetation. These effects could reduce food availability, nesting habitat, and escape cover for birds in the area affected by the spill (Barsdate et al. 1980; Hobbie 1982). A large spill in an area such as a lake used by geese during molting could affect hundreds of birds (BLM 1998). It is estimated that 100,000 to 300,000 birds were killed as a result of the Exxon Valdez spill (Piatt et al. 1990).

A population-level impact from an oil spill could occur if (1) the spill was very large, and/or (2) caused a high loss of individuals of a species that has low reproductive rates, that congregates in only a few areas, that is rare, or that is already stressed (Piatt et al. 1990; MMS 1998). For example, although the Exxon Valdez oil spill killed only 1,000 to 2,000 Kittlitz's murrelets, that was a substantial fraction of a world population that may have numbered only a few tens of thousands. On the basis of survey data, the status for the recovery of Kittlitz's murrelet from the Exxon Valdez oil spill is still considered unknown (Exxon Valdez Oil Spill Trustee Council 1999g).

Bird species most susceptible to oil pollution of water bodies include loons, cormorants, grebes, sea ducks, auklets, murrelets, murres, guillemots, and puffins because they spend much of their time on the water surface, often congregate in dense flocks, depend on intertidal habitats close to shore, or may be flightless while undergoing a complete molt (Piatt et al. 1991). Some species that migrate at sea (e.g., red phalaropes) concentrate in areas such as tide rips, convergence lines, leads in ice, along spits, and in lagoons that are also the types of areas where spilled oil tends to concentrate (Troy 2000). Generally, species that dive for food were negatively affected by the Exxon Valdez spill, whereas those that feed on the surface were not affected (Irons et al. 2000).

Recovery of an affected population from a large oil spill could take one to two generations (two to six years) for common bird species or for species with high reproductive rates. Recovery would take longer for species that have a low reproductive rate (e.g., guillemots and murres) (MMS 1996; Golet et al. in press). On the basis of survey data, the following conclusions have been reached regarding recovery of birds from the effects of the Exxon Valdez oil spill: (1) fully recovered — bald eagle; (2) recovering/recovery clearly under way — black oystercatcher, common murre, and marbled murrelet; (3) not recovered — common loon, cormorants (pelagic, red-faced, and double-crested), harlequin duck, and pigeon guillemot; and (4) unknown — Kittlitz's murrelet (Exxon Valdez Oil Spill Trustee Council 1999a-i). The lack of recovery for several species may be due to persistent oil remaining in the environment and reduced forage fish abundance, coupled with the lack of sufficient reproduction, survival, or immigration (Irons et al. 2000).

Oil spills that occur in aquatic systems could also affect some terrestrial mammals. For example, if a spill entered waters in the Gulf of Alaska during the middle of winter, Sitka black-tailed deer that forage heavily on kelp and other tidal vegetation during this time could be adversely affected. However, the Sitka black-tailed deer that feed on kelp are usually in a poor state of health and would be expected to die of starvation anyway. Deer in good health would not likely be on the beach (Ballard and Whitlaw 2002). A summer or fall spill that contaminated coastal streams, beaches, mudflats, or river mouths could be detrimental to brown bears that feed on fish during these seasons. River otter, beaver, muskrat, and mink are among terrestrial mammal species more vulnerable to the direct effects of oiling. They would have similar sensitivities as sea otters to a loss of thermal insulation and are also likely to ingest contaminants while attempting to clean their fur (MMS 1995). Survey data indicate that the river otter has recovered from the effects of the Exxon Valdez oil spill (Exxon Valdez Oil Spill Trustee Council 1999j).

Terrestrial mammals exposed to oil are not as likely as birds to suffer from the loss of insulation. While most herbivores would avoid consuming oiled plants, contaminants could be absorbed through the skin, inhaled, or ingested (e.g., while trying to clean their fur) (MMS 1998). Duffy et al. (1996) reported that after exposure to crude oil, individual animals might exhibit acute and/or chronic immune system responses. They suggested that any subsequent secondary infections or tissue damage could lower individual survivorship and thus impact the population. Long-term, low-level contamination of food resources and habitats could cause chronic toxicity of terrestrial mammals because of the accumulation of hydrocarbon residues that may adversely affect physiology, growth, reproduction, and behavior (MMS 1995).

The Exxon Valdez incident caused the largest water-based oil spill (i.e., 10.9 million gal) in Alaska history. The effects of that spill have been summarized in several key references, including (1) *Exxon Valdez Oil Spill: Fate and Effects in Alaskan Waters* (Wells et al. 1995), and (2) *Proceedings of the Exxon Valdez Oil Spill Symposium* (Rice et al. 1996). No comparably large land-based oil spills have occurred. Nevertheless, potential effects of land-based oil spills have been summarized in various oil and gas lease sale EISs (e.g., ADNR 1999; MMS 1995, 1996, 1998).

For purposes of analysis, a number of postulated surface-water spill scenarios have been identified for the proposed action. These scenarios include spills into a number of rivers and streams from the pipeline (Section 4.4.1) and spills into Port Valdez from the Valdez Marine Terminal (Section 4.4.1.2). Generally, small to moderately large pipeline spills (<100 to 10,000 bbl) would be *anticipated* (>0.5/yr) or *likely* (0.03 to 0.5/yr), respectively. In contrast, a large, catastrophic spill of up to 54,000 bbl (e.g., from a pipeline guillotine break) would be *unlikely* (10^{-3} to 0.03/yr) or *very unlikely* (10^{-6} to 10^{-3}/yr) (Section 4.4.1). A small to moderate spill at the Valdez Marine Terminal (0.02 to 1,700 bbl) into Port Valdez would be anticipated or likely; whereas the largest potential catastrophic spill of 143,450 bbl would be very unlikely. In addition to the volume and rate of the oil spill, the length of stream reach impacted would depend on stream flow rate and width for a spill to a river or stream, or on weather and tidal conditions for a Port Valdez spill. The longest slick from the maximum postulated spill into a river would be up to 3.2 mi long under low-flow conditions and up to 12.7 mi long under high-flow conditions. However, the stream length that would be contaminated by the slicks as it flows downstream cannot be predicted with certainty, although it would undoubtedly be a much greater length.

In contrast to a surface-water oil spill, which could be transported by the water, a land-based oil spill from the pipeline would contaminate a limited area. A number of land-based spill scenarios have also been identified for continued operations of the TAPS (Table 4.4-1). Generally, small to moderately large spills (≤100 to ≤10,000 bbl) would be anticipated to occur more than once every 2 years, to 0.03 to 0.5 times per year. Depending on the thickness of the spill, small to moderate spills would affect an area of 0.1 to <16 acres (0.0002 to 0.025 mi^2). In contrast, a large, catastrophic land-based oil spill of up to 54,000 bbl (e.g., from a guillotine break) would be unlikely to very unlikely, but if it did occur, it could contaminate an area from 1 to 84 acres (0.002 to 0.13 mi^2).

Given the estimated area potentially affected, a land-based oil spill would affect relatively few individual animals and a relatively limited portion of the habitat or food resources for large-ranging mammal species (e.g., moose, caribou, bear, and wolf) (ADNR 1999). A land-based spill would not cause significant impacts to movement (e.g., migration) or foraging activities at the population (herd) level, largely because of the vast amount of surrounding habitat that would remain unaffected (MMS 1998). The area impacted for even the largest potential spill from a guillotine break (i.e., 0.13 mi^2 [84 acres]) would be very small compared with the home range occupied by the larger wildlife species. For example, the Nelchina caribou herd occupies about 20,000 mi^2 (12.8 million acres), while in GMU 13 there is about 16,600 mi^2 (10.6 million acres) of wolf habitat, or about one wolf per 33 mi^2 (one wolf per 21,120 acres) (ADNR 2000). Impacts to large mammals could result if an oil spill occurred in an important use or concentration area, such as denning sites, calving grounds, or insect relief sites. However, it is doubtful that more than a few individuals of any given species would be impacted by a land-based spill.

Generally, the small mammal species that have small home ranges and/or high densities per acre would be most affected by a land-based oil spill. Potential impacts to mammals can be estimated by comparing the spill area to the species' home range or density. For example, the maximum contaminated area of (0.13 mi^2) 84 acres could be inhabited by more than 6,100 shrews or more than 10,000 brown lemmings (Nowak 1991). Squirrels and other arboreal species would be able to avoid direct oiling, although portions of their habitat would be contaminated by the oil or otherwise impacted from spill response and restoration activities.

APSC has several response strategies to protect wildlife from an oil spill: (1) hazing birds and mammals to cause them to leave the area; (2) collecting dead, oiled wildlife to protect scavengers from feeding on contaminated carcasses; and (3) capturing and treating oiled birds (APSC 2000c). As necessary, any bird species can be hazed; the mammal species that can be hazed are caribou, musk ox, moose, brown bear, black bear, Dall sheep, American bison, mountain goat, gray wolf, Arctic fox, and red fox. Yearly permits from the Alaska Department of Fish and Game are required to haze wildlife, and hazing can only be performed by trained individuals. Hazing can also be performed to protect oil spill response workers from wildlife at spill sites, field camps, staging areas, waste disposal sites, and other areas. Wildlife hazing is allowed 2 mi to either side of the TAPS corridor, 2 mi to either side of Richardson and Dalton Highways, nonmarine areas within the Valdez Marine Terminal, one-half mile to either side of a river that is perpendicular to the TAPS or the highways (for a downstream distance of 30 mi), and 2 mi to either side of a river with portions that parallel within 2 mi of the TAPS or the highways (ADF&G 2002a,b).

Human presence and activities associated with response to spills of oil and other hazardous substances would also disturb wildlife in the vicinity of the spill site and spill-response staging areas. Such activities could be more intensive and prolonged than normal pipeline maintenance and operation and could disturb and displace larger numbers of animals. In addition to displacing wildlife from areas undergoing oil cleanup activities, habitat damage could also occur from cleanup activities. For surface water spills, birds could be disturbed by vessel traffic on the water and from other oil spill cleanup activities within their nesting, foraging, staging, or molting areas. Such activities could contribute to reduced reproductive success.

Disturbance could last for one or two seasons during cleanup operations, causing displacement of wildlife (e.g., caribou, musk ox, wolves, and wolverines) within 1 mi of these activities (MMS 1996). Some species, such as foxes and bears, could be attracted to human activity because of the possibility of finding food (ADNR 1999), although hazing would be conducted to protect workers. Avoidance of contaminated areas by wildlife during cleanup due to disturbance or hazing would minimize the potential for large herbivores to graze on the oiled vegetation before site cleanup is completed.

In summary, a spill would exclude large, wide-ranging terrestrial mammals from relatively small portions of their home ranges, although behavioral disturbance by spill response activities would extend the functional loss of habitat area. Temporary loss of available habitat would occur for birds and small mammals. Such losses would encompass a negligible portion of habitat available within the distributional range of such species. Wildlife habitat would be impacted for the length of time it takes for cleanup and restoration. This period could range up to several years or more.

4.4.4.12 Threatened, Endangered, and Protected Species

Spills that could occur as a result of the proposed action have the potential to affect threatened, endangered, and protected species. Impacts to these species can occur either directly through external contact (oiling) or ingestion or indirectly through the contamination of habitats or food supplies. These types of impacts were described previously in Section 4.4.4.9 (impacts to terrestrial vegetation and wetlands), Section 4.4.4.10 (impacts to fish), and Section 4.4.4.11 (impacts to birds and terrestrial mammals). This section examines the expected relative magnitude of impacts on threatened, endangered, and protected species that could occur when oil is spilled either on land or in the water. The assessment is based on the frequency, location, and volume of spills and the area that would be affected by spills. A summary of potential impacts is presented in Table 4.4-37.

The spill scenarios described in Section 4.4.1 serve as the basis for this analysis. The scenarios evaluated are representative of the range of spill volumes that could occur as a result of a variety of initiating factors including human error, equipment failure, corrosion, sabotage, natural events (e.g., washout, earthquakes), transportation accidents, and catastrophic accidents, such as a plane crash. Spills are categorized as *anticipated, likely, unlikely,* or *very unlikely*. It is important to recognize that, for pipeline spills, these probabilities represent the probability of occurrence for the entire pipeline, regardless of location. The probability of occurrence at any specific location (e.g., on the North Slope, where many of the threatened, endangered, and protected species occur, or at a particular river crossing) is much lower. In addition, the magnitude of impact to threatened, endangered, and protected species would be affected by the time of year in which the spill occurred. Spills that occurred during periods when these species were not present in the area would have less impact than if the spill occurred during the period of residence.

On the basis of the distribution of listed and protected species in the project area, spills are discussed for the North Slope (including the Beaufort Sea), the Interior Alaska, and Prince William Sound. Few of the listed or protected species are found in more than one of these regions. Spills are further categorized as spills to land or to water.

Spills to land on the North Slope have the potential to affect spectacled eider, Steller's eider, Arctic peregrine falcon, and polar bear. Impacts of a land spill could result from direct oiling of individuals (especially eiders), effects on the food base of species, and habitat impacts, such as reduced productivity and changes in the species composition of plant communities. The largest *anticipated* spill is 100 bbl, which could contaminate an area up to 0.15 acre. The largest *likely* spill is 10,000 bbl, which could contaminate an area up to 15 acres. Spills that are considered *unlikely* or *very unlikely* could be as large as 54,000 bbl (resulting from a guillotine break of the pipeline) and contaminate an area up to 84 acres. Although the amount of oil spilled in these scenarios is quite large, the size of the area that would be contaminated and require cleanup is relatively small, thus reducing the likelihood of impact to listed or protected species.

Spills to water bodies on the North Slope would have the potential to affect spectacled eider, Steller's eider, Arctic peregrine falcon, bowhead whale, beluga whale (Beaufort and Chukchi stocks), bearded seal, ribbon seal, ringed seal, spotted seal, Pacific walrus, and polar bear. For the most part, only very unlikely spills (e.g., the maximum release of 54,000 bbl to the Dan Creek/Sagavanirktok River resulting from a guillotine break of the pipeline) would have an important impact on listed or protected species and then only if the spill could not be contained before it entered the Beaufort Sea. Of these species, the spectacled eider, Steller's eider, Arctic peregrine falcon, beluga whale, spotted seal, and polar bear are the most likely to be adversely affected because they can occur along North Slope rivers and near the coast,

TABLE 4.4-37 Potential Impacts of Oil Spills on Threatened, Endangered, and Protected Species

Species	Listing Status	Time of Year	Locations	Potential Effect of Spill	
				Spill to Land	Spill to Water
Birds					
American peregrine falcon	ESA-DM AK-SC	April – Sept.	Near rivers and lakes south of Brooks Range (MP 240–800)	Low-volume spills that are anticipated or likely to occur are not expected to have population-level effects. A high-volume, but very unlikely, spill could affect up to 84 acres of habitat but is not expected to result in a measurable change in the population.	Low-volume spills that are anticipated or likely to occur are not expected to have population-level effects. A high-volume, but very unlikely, catastrophic spill to a river could affect a large segment of the river and would affect habitat and the species' primary food supply (waterfowl).
Arctic peregrine falcon	ESA-DM AK-SC	April – Oct.	Near Sagavanirktok River (MP 0–110)	Same as American peregrine falcon.	Same as American peregrine falcon.
Blackpoll warbler	AK-SC	April – Oct.	Coniferous and mixed forest south of Brooks Range (MP 240–800)	Same as American peregrine falcon.	No effect because species is not dependent on aquatic or riparian habitats.
Eskimo curlew	ESA-E AK-E	NA	NA	No impacts anticipated because species is probably extinct.	
Gray-cheeked thrush	AK-SC	May – Oct.	Coniferous and mixed forest south of Brooks Range (MP 240–800)	Same as American peregrine falcon.	Same as blackpoll warbler.
Olive-sided flycatcher	AK-SC	April – Oct.	Coniferous forest south of Brooks Range (MP 240–800)	Same as American peregrine falcon.	Same as blackpoll warbler.

TABLE 4.4-37 (Cont.)

Species	Listing Status	Time of Year	Locations	Potential Effect of Spill: Spill to Land	Potential Effect of Spill: Spill to Water
Spectacled eider	ESA-T AK-SC	May – Sept.	Wetlands and ponds of Arctic Coastal Plain (MP 0–40)	Low-volume spills that are anticipated or likely to occur are not expected to have population-level effects. A high-volume, but very unlikely, spill could affect up to 84 acres of habitat but is not expected to result in a measurable change in the population. Impacts of such a spill could result from loss of wetland habitat, effects on food base (aquatic invertebrates and plants), possible oiling of individual birds, and incidental ingestion of oil.	Low-volume spills that are anticipated or likely to occur are not expected to have population-level effects. A high-volume, but very unlikely, catastrophic spill to the Sagavanirktok River could affect a large segment of the river, including habitat in the river's delta in the Beaufort Sea. Impacts could result from habitat loss (shoreline wetlands), impacts to the food base (aquatic invertebrates and plants) and possibly oiling of individual birds. The generally low number of birds in the affected area would limit population-level impacts.
Steller's eider	ESA-T AK-SC	May – Sept. along ROW; winter in Prince William Sound	Wetlands and ponds of Arctic Coastal Plain (MP 0–40); Prince William Sound	Same as spectacled eider.	Same as spectacled eider.
Townsend's warbler	AK-SC	April – Oct.	Coniferous forest in Yukon River valley (MP 540–800)	Same as American peregrine falcon.	No effect.
Mammals					
Bearded seal	MMPA-P	All year	Beaufort Sea	No effect.	Low-volume spills that are anticipated or likely to occur are not expected to have population-level effects. A high-volume, but very unlikely, catastrophic spill to the Sagavanirktok River could affect this species if the spill were not contained before it entered the Beaufort Sea. Impacts to the species could result from impacts to the food base, oiling of individual animals, and incidental ingestion of oil.
Beluga whale Beaufort Sea and Chukchi stocks	MMPA-P	Summer	Beaufort Sea	No effect.	Same as bearded seal.

TABLE 4.4-37 (Cont.)

Species	Listing Status	Time of Year	Locations	Potential Effect of Spill: Spill to Land	Potential Effect of Spill: Spill to Water
Beluga whale Cook Inlet stock	MMPA-D	Winter	Prince William Sound	No effect.	Spills at the Valdez Marine Terminal are not expected to affect species because spill response and cleanup actions are expected to limit the area affected within Port Valdez.
Bowhead whale	ESA-E MMPA-D AK-SC	Summer	Beaufort Sea	No effect.	Same as bearded seal.
Dall's porpoise	MMPA-P	All year	Prince William Sound	No effect.	Same as beluga whale, Cook Inlet stock.
Fin whale	ESA-E MMPA-D	April – June	Prince William Sound	No effect.	Same as beluga whale, Cook Inlet stock.
Gray whale	ESA-D MMPA-P	Late spring and early fall	Prince William Sound	No effect.	Same as beluga whale, Cook Inlet stock.
Harbor porpoise	MMPA-P	All year	Prince William Sound	No effect.	Same as beluga whale, Cook Inlet stock.
Harbor seal	MMPA-P	All year	Prince William Sound	No effect.	Low-volume spills that are anticipated or likely to occur at the Valdez Marine Terminal are not expected to have population-level effects. A high-volume, but very unlikely, spill resulting from a catastrophic rupture of a crude oil storage tank at the Valdez Marine Terminal could affect the population inhabiting Port Valdez through food base effects, oiling individual animals, incidental ingestion of oil, and contamination of shoreline habitats.
Humpback whale	ESA-E MMPA-D AK-E	Summer	Prince William Sound	No effect.	Same as beluga whale, Cook Inlet stock.
Killer whale	MMPA-P	All year	Prince William Sound	No effect.	Same as beluga whale, Cook Inlet stock.

TABLE 4.4-37 (Cont.)

Species	Listing Status	Time of Year	Locations	Potential Effect of Spill: Spill to Land	Potential Effect of Spill: Spill to Water
Minke whale	MMPA-P	Summer	Prince William Sound	No effect.	Same as beluga whale, Cook Inlet stock.
Pacific walrus	MMPA-P	Summer	Beaufort Sea	No effect.	Same as bearded seal.
Pacific white-sided dolphin	MMPA-P	All year	Prince William Sound	No effect.	Same as beluga whale, Cook Inlet stock.
Polar bear	MMPA-P	All year	Beaufort Sea	Low-volume spills that are anticipated or likely to occur are not expected to have population-level effects. A high-volume, but very unlikely, spill could affect up to 84 acres of habitat but is not expected to result in a measurable change in the population. Impacts would result from habitat loss (tundra), possible oiling of individuals, and incidental ingestion of oil.	Low-volume spills that are anticipated or likely to occur are not expected to have population-level effects. A high-volume, but very unlikely, catastrophic spill to the Sagavanirktok River could affect this species if the spill were not contained before it entered the Beaufort Sea. Impacts to the species could result from impacts to the food base, oiling of individual animals, incidental ingestion of oil, and impacts to riverine shoreline habitat.
Ribbon seal	MMPA-P	All year	Beaufort Sea	No effect.	Same as bearded seal.
Ringed seal	MMPA-P	All year	Beaufort Sea	No effect.	Same as bearded seal.
Sea otter	MMPA-P	All year	Prince William Sound	No effect.	Same as harbor seal.
Spotted seal	MMPA-P	July to Oct.	Beaufort Sea	No effect.	Similar to bearded seal. Potential impact greater than for other seals because spotted seal uses coastal and river mouth habitats.
Steller sea lion	ESA-E MMPA-D AK-SC	All year	Prince William Sound	No effect.	Same as harbor seal.

where the impacts of a spill would be greatest. Other listed and protected species would not likely be adversely affected by even the worst-case spill because they use habitats farther from the coast where the effects of a spill would be minimal.

A number of factors would reduce the likelihood of adverse effects to listed or protected species from land spills associated with the proposed action:

- Any spills that occurred at the pump stations would be contained entirely within the pump station boundaries.
- Some, and perhaps most, oil leaked from the pipeline would remain on the graveled workpad.
- Underground leaks would not likely affect these species unless the oil ultimately entered surface water or came to the ground surface.
- The probability that a spill would occur in areas where listed or protected species are present on the North Slope is only 14% of the probabilities for the entire pipeline.
- For land spills, the maximum area that could be affected is small and, because the estimate is based on very conservative assumptions, the spill area is likely to actually be much smaller.
- Spill response actions described in Section 4.2 would reduce the area affected by a spill and result in cleanup and restoration of the spill area.
- Most species are present in the project area for only a portion of the year, thus reducing the likelihood of any direct spill effects such as oiling.
- Listed and protected species occur in low densities in the project area, which greatly reduces the number of individuals that could be affected by a spill.

No federally listed species occur along or in the vicinity of the pipeline in the interior, between the Brooks Range and Prince William Sound (MP 240 to 800). Several species in this region, however, are considered species of special concern by the State of Alaska. These species include American peregrine falcon, blackpoll warbler, gray-cheeked thrush, olive-sided flycatcher, and Townsend’s warbler. The American peregrine falcon was recently removed from the federal list of threatened and endangered species.

Low-volume spills, considered anticipated or likely during the 30-year renewal period, would generally be expected to have only very small, if any, impact if the spill occurred on land because of the relatively limited area that could be affected (0.15 acre or less). High-volume spills, considered unlikely or very unlikely to occur, are expected to have minor impacts because these spills also would affect relatively small areas of land (84 acres or less). All of the species occupy forested areas and spend little, if any, time on the ground. They are, therefore, unlikely to come into contact with spilled oil. An impact would only be expected if spilled oil resulted in the loss or modification of forest habitat used by the species.

Spills to water bodies in the interior are not likely to have an effect on any of the species of concern except for the American peregrine falcon. The falcon could be affected by a high-volume spill into a river such as the Yukon River or Tanana River. Such a spill is likely to contaminate large stretches of river and shoreline because the flow in these high volume rivers would carry spilled oil far downstream before the spill could be contained. The impact to the peregrine falcon of a high-volume spill into a river is potentially large because it could affect waterfowl, which are an important food of the falcon. The probability of a high-volume spill occurring somewhere along the pipeline is considered unlikely or very unlikely. The probability of such a spill occurring at a river crossing is much smaller still because river crossings are a small portion of the entire pipeline.

Threatened, endangered, and protected species in Prince William Sound include Steller’s eider, beluga whale (Cook Inlet stock), Dall’s porpoise, harbor porpoise, Pacific white-sided dolphin, killer whale, fin whale, gray whale, humpback whale, minke whale, harbor seal, Steller sea lion, and sea otter. These species would only be affected by a spill at the Valdez Marine Terminal if oil entered Port Valdez. Several of the scenarios examined would result in oil or fuel entering Port Valdez. Anticipated spills would result in very small volumes (0.5 bbl or less) entering Port Valdez. Spills of this size are expected to have negligible impact on listed and protected species. The largest likely spill (frequency of 3 in 100 years or 1 during the renewal period) would result in the release of 1,700 bbl of oil into Port Valdez. A spill of this volume would contaminate a limited area near the Valdez Marine Terminal and could result in minor short-term impacts to listed and protected species. Spill response, containment, and cleanup would limit the duration of exposure and impact.

Catastrophic rupture of a crude oil storage tank (e.g., foundation or weld failure) at the Valdez Marine Terminal could result in a release of 143,450 bbl into Port Valdez. A spill of this magnitude would be expected to move less than 2 mi before it was contained (see Section 4.4.4.5) and 70% of the oil would remain near the shoreline. Species most likely to be affected by such a spill include harbor seal, Steller sea lion, and sea otter, which utilize shoreline habitats. Other species (whales, porpoises, and dolphins) might be able to avoid the spill area and thus could be less likely to be affected. Impacts would result from impacts to the food base, possible oiling of individuals, incidental ingestion of oil, and contamination of shoreline habitats. Because of the limited area that would be affected by this “worst-case” spill, impacts to listed and protected species would be expected to be reduced.

4.4.4.13 Economics

The economic impacts associated with spills include the impacts that might result both directly from degradation of land and other natural resources, and indirectly to state and local governments as a result of lost oil revenues during periods when the pipeline would be shut down for repair and cleanup activities following a spill. The potential direct economic impacts of spills include impacts to recreation and tourism, mainly in rural locations, and the impacts on property values and local economic activity, primarily in urban locations. The relative importance of the direct and indirect impacts of potential pipeline spills would depend on the size and, to a lesser extent, the location of the spill. For smaller spills that would not require suspending pipeline operations, direct impacts would be primarily a local concern because these impacts would occur in the immediate vicinity of the spill location. Larger spills requiring shutdown of the TAPS would have far more substantial and far-reaching impacts in terms of losses of oil tax revenues to the state and local governments. Offsetting these losses would be the additional employment and income generated if cleanup activities required the hiring of additional spill response staff.

4.4.4.13.1 State and Local Oil Revenues. The state and local governments benefit from a variety of tax revenues levied on oil production and transportation through the TAPS. At the state level, production taxes and royalties produce approximately 75% of state oil revenues and roughly 30% of the overall state budget. Other sources of oil revenue include bonuses, rents, corporate income taxes, and property taxes (Section 3.23.3.5). At the local level, oil revenues constitute approximately 10% of overall revenues, with 40% of property tax revenues coming from the oil industry. Local governments also receive substantial transfers from the state that would also be affected by any fall in oil revenues collected by the state.

Impacts of Oil Spills on State and Local Revenues

A spill from TAPS that would result in lost throughput could have an important impact on state revenues, with production taxes and royalties currently producing about 75% of state oil revenues. At the state level, with a throughput level of 1.1 million bbl/d, shutting down TAPS for a single day could mean that almost $3.5 million in royalties and production taxes would be lost. At the local level, spills would directly impact property taxes, and would also indirectly affect transfers made to local governments from revenues collected by the state.

Table 4.4-38 shows the impact that a spill could have on state revenues for a single day in 2004. Impacts are shown for three representative throughput levels corresponding to (1) the design capacity of the pipeline (2.1 million bbl/d), (2) the minimum economic capacity (0.3 million bbl/d), and (3) the base case (1.1 million bbl/d), thereby bounding the impact of all potential spills from the TAPS. The year 2004 was chosen in order to present impacts in the year that would have a forecasted throughput value (1.086 million bbl/d) (Section 4.3.19.1) closest to the base case used for the analysis (1.1 million bbl/d).

Table 4.4-38 shows daily state oil revenues at the three throughput levels, together with a reference minimum case corresponding to revenues collected by the state only from production at Cook Inlet, with no North Slope production or TAPS operation. Only the major sources of revenue — royalties and production taxes — are shown in detail; the other sources of revenue are included in the total. The difference between state revenues at each of the three throughput levels and revenues with no TAPS throughput are shown. Pipeline spills that result in periods of lost throughput that last longer than a single day can be estimated by multiplying these impacts by the number of days of lost operation.

4.4.4.13.2 Recreation and Tourism. Numerous locations in the pipeline corridor are used for hunting, fishing, and other forms of recreation and general tourist activity, particularly areas north of Fairbanks. Many of these areas have developed because they are easily accessible from the Richardson/Elliott/Dalton Highway complex. Activities in these areas could be affected by spills, depending on the location and extent of the spill, length of cleanup time, and extent to which land, water, and scenic resources were returned to prespill conditions.

Smaller spills would be likely to significantly affect only limited amounts of land used for recreation and tourism. However, given the limited road network in many of the areas through which the pipeline passes, spill response and cleanup might effectively close the road network for periods of time and therefore limit access to areas frequently used for recreation and tourism. Larger spills might not

TABLE 4.4-38 Impacts of Spill Scenarios on Daily State Revenues in 2004 (thousands of 2000 \$)[a]

Source of Oil Revenue	No TAPS Throughput Case per Throughput[b,c]	State Revenues, per TAPS Throughput Level ($\times 10^6$ bbl/d)			Changes in State Revenues Compared with No TAPS Case, per Throughput Level ($\times 10^6$ bbl/d)		
	0.0	2.1	1.1	0.3	2.1	1.1	0.3
Total oil revenues	289	6,649	3,787	1,569	6,359	3,498	1,280
Royalties	157	3,786	1,958	541	3,629	1,801	384
Production taxes	44	2,140	1,107	306	2,096	1,062	261

a Net impacts on annual state revenues may be less than the impacts shown if pipeline throughput can be increased once the pipeline has been returned to normal operations.

b Production at Cook Inlet only.

only limit access to the affected area but also produce long-term damage to larger portions of a particular type of environment not found in areas with similar road access, thus potentially impacting visitor rates in these areas.

Economic Impacts on Recreation and Tourism

The overall economic impact of spills on recreation and tourism would likely be small, although there might be impacts at the local level. Few visitors go to many of the areas in which the pipeline is located, and the majority of spills would not be likely to have any long-term effect on road networks or damage natural resources or types of landscape that are not present elsewhere in the state.

For both smaller and larger spills, the economic impact of any decline in visitor rates in tourist and recreational areas would be likely to be small. Visitors would not be present in any great numbers in any of these areas, and as long as the road network was not closed for significant periods and there was no long-term damage to broad areas of natural resources or landscape, long-term trends in visitor rates would not likely be affected. The local and state economic impacts of potential spills to recreational resources or tourism would therefore likely be minimal. More information on the impact of spills on land use and recreation in specific locations along the pipeline is provided in Sections 4.4.4.17 and 4.4.4.18.

4.4.4.13.3 Property Values and Changes in Economic Activity.

Contamination of land or buildings resulting from a spill has the potential to affect property values in a particular location and overall economic activity in a wider geographic area. The nature and extent of the impact would depend on the location of the spill, the extent and nature of the damage, and the time taken for the cleanup process to return the affected property or activities to normal.

While property values could potentially be adversely affected at all locations along the pipeline, measurement of these losses might be possible only in locations where land has a clearly established market value and where the value of property is estimated for the assessment of property taxes. Property taxes are collected at three jurisdictions along the pipeline — Fairbanks North Star, North Slope, and Valdez-Cordova. The potential impacts of spills to property values would largely depend on the proximity of the pipeline to other local economic activities. These areas are mostly in population centers and in commercial and industrial developments that might be located in either urban or rural areas. The pipeline ROW is adjacent to a population center only in Fairbanks, where it is located within the city limits; to a much lesser extent, in Valdez, where it is located some 12 road miles from the Valdez Marine Terminal; and in Prudhoe Bay, where it is located approximately 5 mi from the community of Deadhorse.

Impacts of Oil Spills on Property Values and Overall Economic Activity

While spills might affect property values in all areas along the pipeline, impacts might only be measurable in locations where the market value of land and real estate can be established. Spills might affect property values in Fairbanks, where there are a number of alternate local uses of potentially affected land. In the North Slope Borough and in Valdez, however, for much of the land, there is little established alternate use, consequently limiting possible impacts on property value. Spills might affect overall economic activity if critical infrastructure was affected and if local labor and other resources were diverted into cleanup activities. Positive employment and income effects might occur if additional cleanup staff was required.

A spill in Fairbanks has the potential to affect property values, since some commercial and residential activities are located close to the pipeline ROW within the city limits and along the Richardson/Elliott Highway north and east of the city. However, this area contains relatively low-density development; the main population center is located about 7 mi to the southwest of the pipeline itself. The likelihood of a spill producing long-term effects to many buildings or on more than a small number of land parcels is relatively small. In the North Slope Borough and in Valdez-Cordova, there are few other economic uses for land in the vicinity of the pipeline ROW. It is therefore unlikely that a spill would have any significant impact on local property values in either area.

In addition to the impacts on property values, spills might also impact overall economic activity in a location. Smaller spills would be more likely to affect economic activity if key resources, such as local agricultural products, industrial materials, and other supplies, were temporarily unavailable, since spill response and cleanup activities have priority over local road networks. Critical infrastructure, such as bridges, key road segments, port facilities, or an airport, might also be taken out of use as a result of the spill or subsequent cleanup. While the impacts of small spills such as these might create a certain amount of disruption in the local economy, the effects on employment, income, and tax revenues would likely be minor and short term. In addition, since the existing labor force would probably be able to provide teams to handle spill response and cleanup, there would likely be little or no additional impact on local employment, income, and tax revenues.

Larger spills might create additional problems if the demand for local resources for spill response and cleanup efforts was such that economic resources were diverted from normal uses. Fuel, water, or other supplies, for example, might be needed to deal with a larger spill, and use of these resources for spill control and cleanup might be given priority over normal local uses. Temporary losses of employment, income, and tax revenues might occur as a result. Spill response teams might need to hire additional people for spill response and cleanup. While this would offset losses in employment and income elsewhere in the local economy, additional burdens might also be placed on state and local government budgets if a large spill response or cleanup workforce moved into an area, thereby impacting the ability of local authorities to continue to provide public services at current levels.

4.4.4.14 Subsistence

Certain spill scenarios presented in Section 4.4.1 have important implications for subsistence along the TAPS ROW. How spills would affect subsistence resources and activities generally varies for different categories of geographic settings — with spills in terrestrial settings differing in important, fundamental ways from spills in rivers and spills in Prince William Sound. Spills would also vary in frequency, or likelihood of occurrence, and magnitude. Less probable events would tend to yield larger volume spills compared with more likely events. The spill scenarios summarized in Tables 4.4-1 and 4.4-2 present four categories of spills — *anticipated* (> 0.5/yr), *likely* (0.03 to 0.5/yr), *unlikely* (10^{-3} to 0.03/yr), and *very unlikely* (10^{-6} to 10^{-3}/yr) — with accompanying estimates of spill volumes.

This section examines spills in each of the three main types of geographic settings and for each spill frequency category separately. The

Impacts of Oil Spills on Subsistence Resources

Impacts to subsistence fisheries from high-volume spills in rivers or streams would likely occur under certain conditions (shallow river or stream, low flow, key period in resident or anadramous fish life cycle).

Impacts to subsistence fisheries are possible from spills of smaller volumes (e.g., 10,000 bbl) in rivers or streams, although such impacts would be more dependent on the nature of the waterway and the timing of the spill than would the consequences of a large spill.

Negative impacts to terrestrial subsistence activities could result from large spills that produced high, population-level impacts on birds and terrestrial mammals. However, the tendency towards geographic dispersion of many terrestrial subsistence resources, coupled with the geographic size of terrestrial harvest areas and the distance of much (or all) of each such area from the TAPS, suggests that impacts likely would be small.

evaluation also considers impacts of transportation-related accidents, summarized in Table 4.4-3, that could affect both terrestrial and river settings. However, because the spill volumes for transportation accidents all would be well below those described for pipeline operations, their impacts on subsistence would be less than the impacts of the other scenarios examined.

Terrestrial spills could occur in all four frequency categories and as a result could involve a wide range of release volumes — from a few barrels of oil to tens of thousands of barrels (see Table 4.4-1). Small terrestrial spills, including those in the *anticipated* and *likely* frequency categories and those based on lower pipeline throughput, although often more probable than large-volume spills, would have smaller impacts on terrestrial subsistence resources than the larger releases discussed in the following paragraphs.

Under a worst-case accident, a guillotine break in the pipeline could produce a spill as large as 54,000 bbl of crude oil under both *unlikely* and *very unlikely* scenarios (see Table 4.4-1). Shallow (1-in.-deep) oil coverage in relatively flat terrain during the highest pipeline throughput considered could affect 84 acres (see Table 4.4-5). Although this large coverage was estimated to occur in a particular area along the TAPS (MP 448 to 453), its location has little importance in terms of terrestrial subsistence resources. Impacts would be small in comparison to the terrestrial resources available to any of the rural communities examined in the DEIS. Although subsistence resources might be damaged, they would primarily be those that could not move or otherwise avoid the effects of the spill, primarily plant resources (berries, wood for fire or construction, etc.) (see Section 4.4.4.9) and smaller animals with limited home ranges (see Section 4.4.4.11). Most of the subsistence resources found in terrestrial settings that are important to rural Alaskans, namely small and large mammals and birds, for the most part could avoid the impact area with little or no effect on their populations or areas of activity. Access to terrestrial subsistence resources thus would change little, and overall impacts would likely be quite small, even when large spills were involved.

In the analysis of impacts on birds and terrestrial mammals resulting from a large spill, it is concluded that high, population-level negative impacts could occur should the spill affect a large concentration of animals (see Section 4.4.4.11). Although a large-scale impact of this nature could have serious adverse implications for terrestrial subsistence, the tendency for key terrestrial subsistence resources to be geographically dispersed, coupled with the large size of subsistence-harvest areas (enabling hunters to easily avoid spill areas) and the distance of much (or all) of each area from the TAPS, suggest that impacts to subsistence likely would be small.

In contrast to spills on land, spills into rivers could have much more serious consequences for subsistence. The evaluation of spills on fish provides a sense of the impacts under various conditions (see Sections 4.4.4.3 and 4.4.4.10). Impacts would vary considerably under different conditions — the key variables being spill volume, waterway characteristics (primarily amount of water flowing through a river and water depth), and timing of a spill with respect to life cycle of the affected subsistence resource. The most serious conditions would be a large spill in a small waterway under low-flow conditions during a sensitive period of anadromous or resident fish life cycles (e.g., spawning, overwintering), although any of these circumstances individually could have serious consequences for subsistence fisheries.

Small, more probable spills would have lesser impacts on subsistence resources in rivers than would large, less likely spills. The particular conditions surrounding the spill would play an important role in the magnitude and nature the impacts experienced. Small volume spills of the *anticipated* frequency would have lesser subsistence impacts than would the larger spills associated with lower-probability events. However, the consequences of these (as well as larger) spills could include changes in growth rates, feeding rates, reproduction, survival, and displacement of individual fish — all with potentially important, although delayed, implications for subsistence. Spill scenarios considered under *likely* probabilities could lead to releases of up to 10,000 bbl. Such a spill could have moderate to serious impacts on fish, and hence subsistence fishing, if it occurred during a sensitive period in the life cycle of the fish species involved or occurred in a small stream or shallow river (see Section 4.4.4.10).

The highest volume spills would occur under an *unlikely* or *very unlikely* scenario — a guillotine break in the pipeline caused by a fixed-wing airplane crash or helicopter crash (up to 54,000 bbl released). The amount of river affected would depend on rate of stream flow and time required for the oil to drain from the pipeline. Estimated lengths of stream affected, depending on spill response time and effectiveness of response, could exceed 47 mi in the case of the Tanana River (see Table 4.4-15). A broad range of possible spill conditions has been projected in Section 4.4.4.10, from Minton Creek (low water volume, yielding high oil-to-water concentrations) to the Yukon River (large water volume, yielding low oil-to-water concentrations). Impacts on subsistence fisheries would vary accordingly.

In larger, deeper rivers, such as the Yukon, impacts of relatively low concentrations of oil (because of large water volume) likely would be limited to organisms located near the shoreline and eggs and larvae on the surface of the exposed area. Subsistence impacts in such a situation would be limited. In contrast, in small streams and shallower rivers (e.g., the Gulkana River), concentrations of crude oil from a spill of the magnitude considered here likely would be lethal to virtually all aquatic organisms. Subsistence impacts for these smaller-volume or shallower waterways would be large. In the case of the Gulkana River, people in the communities of Copper Center, Gakona, Glennallen, Gulkana, Kenny Lake, Paxson, and Tonsina all rely to one degree or another on this body of water for subsistence and thus would experience impacts from such a spill (Appendix D). That stated, once again is it is very unlikely that such an event would occur. For example, as discussed in Section 4.4.4.3.1 the likelihood of a helicopter crash presented in Table 4.4-1 (2.9×10^{-5}) is for the entire length of the pipeline. The likelihood of such a crash involving a specific 300-ft length of bridge crossing a particular river or stream would be much less — about 1 in 255 million.

Oil spills into Prince William Sound from the TAPS constitute a third category of potential accidents that could result in subsistence impacts. Spills of the *anticipated, likely,* and *unlikely* frequency categories would be more probable than would a *very unlikely* spill event but would yield much smaller impacts than those discussed below for the *very unlikely* category. However, even for the more frequent, lower volume spill categories, perceived problems with various resources might preclude subsistence activity in a geographic area larger than that actually affected by a spill, although in the cases of these more probable spills, the areas actually affected would be quite small.

The *very unlikely* spill scenario involving a catastrophic rupture of a crude oil storage tank could allow more than 143,000 bbl of oil to reach the waters of Port Valdez at the Valdez Marine Terminal. Despite this large volume, hydrological analysis suggests that the spilled oil likely would move less than 2 mi before containment by spill response efforts, with about 70% of the oil remaining close to the shoreline (see Section 4.4.4.5). Various subsistence resources — fish, invertebrate marine species, seabirds and shorebirds, and possibly certain marine mammals (e.g., sea otters) — could all be adversely affected by such a spill. However, given the limited spatial dispersal of oil under this scenario, the area affected would be small relative to the entire Prince William Sound and its coastline. The subsistence resources likely subjected to the greatest impacts would be those that could not avoid the oil, primarily those living near the shore and unable to move quickly, such as certain invertebrates, and those living at or near the affected shoreline. In all such situations, impacts should be limited by the expanse of the spill and by response capabilities. Impacts to subsistence resources are not expected to be large, because of the relatively small geographic dispersal of the spill, the small subsistence harvest area near the spill site (for Tatitlek; see Appendix D), and the likely ability of subsistence users to shift their activities to avoid the relatively small area affected. That stated, the perception that subsistence resources are dangerous or otherwise unusable might have a broader geographic impact, recalling issues associated with scientific evaluations and perception associated with the Exxon Valdez spill (Fall 1999).

It is important to acknowledge that subsistence impacts of any spill would in part be a function of the magnitude and location of the spill and in part a function of the timing and thoroughness of spill response. The APSC maintains spill response plans for a range of such eventualities (APSC 2001m). Rapid, efficient implementation of these plans would serve to reduce impacts to subsistence resources and hence to subsistence.

Impacts of Oil Spills on Sociocultural Systems

High-volume spills in rivers or streams under certain combinations of conditions (shallow river or stream, low flow, key period in resident or anadromous fish life cycle) could have severe impacts on river resources and could lead to possible major disruption in economies emphasizing subsistence. Use of local crews to conduct spill cleanup could provide wage employment to rural Alaskans for whom such employment often is difficult to find. Both of these impacts could affect both Alaska Native and rural non-Native sociocultural systems.

4.4.4.15 Sociocultural Resources

Spills evaluated for the proposed action could have varying effects on a range of resources upon which Alaska Native and rural non-Native sociocultural systems rely and, depending on the situation, could possibly affect the sociocultural systems themselves.[8] Impacts of spills on sociocultural systems, as discussed below, largely are anticipated to be small, although some could be large under certain *unlikely* and *very unlikely* spill scenarios. In general, impacts would vary with the size of area affected, the duration of the effects, and the amount of critical resources affected. The magnitude of sociocultural impacts likely would differ between terrestrial spills, spills in rivers, and spills in Prince William Sound, primarily because of their potential for geographic dispersal, the availability of alternative resources, and the potential to generate long-term adaptive changes. Accordingly, the evaluation here discusses these three major geographic settings separately, exploring the four main frequency ranges in each.

Terrestrial spills, even the largest events categorized as *likely* or *very unlikely*, are not expected to have major effects on sociocultural systems. Such systems comprise the collection of beliefs, ideas, behavioral patterns, and tools that humans use to adapt to their physical and social surroundings. By their very nature, sociocultural systems adapt to changing conditions. Although a large terrestrial spill might indeed devastate a piece of ground as large as 84 acres (see Section 4.4.4.1) and have large negative impacts on local bird or terrestrial mammal populations (see Section 4.4.4.11), current estimates do not indicate that even the largest spill would directly affect any Alaska Native villages or rural non-Native communities considered in this DEIS. Even if a spill affected land relied upon by some or all members of an Alaska Native or non-Native community, those individuals could shift their activities to avoid the spill area and focus on terrestrial resources elsewhere without undue difficulty. Shifts in adaptive patterns would not occur, except possibly as relatively minor geographic changes in areas exploited. Similarly, even if a culturally important locality were affected, the consequences of such an occurrence should not translate into impacts on a sociocultural system (changing economic orientation, kinship patterns, authority structures, etc.). Noteworthy negative sociocultural impacts are not anticipated in such a situation. Smaller spills described as *unlikely* and *very unlikely*, as well

8 Impacts on other resources with possible sociocultural corollaries are discussed elsewhere in Section 4.4.4, including a variety of biological resources (Sections 4.4.4.8 through 4.4.4.12), the economy (Section 4.4.4.13), and subsistence (Section 4.4.4.14).

as more probable *likely* and *anticipated* events, would have a lesser impact on sociocultural systems than their larger counterparts because fewer resources would be affected over smaller areas.

Spills into rivers would have a greater potential to impact sociocultural systems than would spills on land. The most important consequences of such spills would be effects on subsistence. Although potential effects on harvests are discussed elsewhere (see Section 4.4.4.14), the degree to which subsistence impacts would be sufficiently severe to alter a sociocultural system is important for consideration here — perhaps altering the economic system as a whole, causing major changes in a key component of a sociocultural system (e.g., causing a shift in status recognition away from persons with strong subsistence skills), or generating more intangible impacts because of the key role played by subsistence in rural (especially Alaska Native) sociocultural systems. Moreover, the impacts of such a spill to riverine resources could last for several years. Impacts on resources with sociocultural implications may take the form of reductions in fish populations as well as perceived damage to subsistence fisheries even after scientific examinations have declared the resources safe, as occurred following the Exxon Valdez oil spill in Prince William Sound (see Fall 1999a).

Smaller, more probable spills in rivers would have lesser impacts on sociocultural systems than their large counterparts. The particular conditions associated with the spill would play an important role in determining impacts, because spills occurring under *likely* probability scenarios could have moderate to high negative impacts on a riverine subsistence fishery if they occurred in shallow, low-volume rivers at a key time in fish reproduction (for instance). Smaller-volume spills, generally associated with *anticipated* events, would have reduced impacts on sociocultural systems by virtue of their lessened impact on local economies. However, the consequences of these (as well as larger) spills could include changes in fish growth patterns, feeding rates, reproduction, survival, and displacement of individual fish — all with potential, though delayed, negative impacts on those components of local rural economies heavily reliant on subsistence fisheries.

The impacts of large spills, on the other hand, could be substantial for local manifestations of sociocultural systems where part of the seasonal round relies on fishing in a particular river or stream devastated by a spill. In particular, large-volume spills (especially 54,000-bbl releases) in shallow waterways under low-flow conditions during sensitive periods in anadromous or resident fish life cycles (e.g., spawning) would have large impacts on subsistence fisheries. However, such spill scenarios are highly improbable in general (see Table 4.4.1-1), less likely to affect a river (about 1 in 255 million chance for a guillotine break caused by a helicopter crash; see Section 4.4.4.3), and still more unlikely under the flow conditions and life-cycle timing conditions discussed above. Moreover, given the inherent adaptability of sociocultural systems and the broad areas exploited for fishing (Appendix D), the severity of such impacts might well be lessened by subsequent adjustments, such as shifts of subsistence activities to other rivers or other portions of an affected river.

The third geographic category of spills considered in assessing impacts on sociocultural systems is oil releases into Prince William Sound. Spill scenarios for Prince William Sound under the *anticipated, likely,* and *unlikely* categories would have greater frequencies of occurrence than a *very unlikely* spill event, but would yield much smaller volumes of spilled material affecting much smaller areas than the maximum release scenario discussed below. Impacts to Alaska Native and rural non-Native sociocultural systems should be similarly small, because of the limited effect on key subsistence and commercial fishing resources (many spills would not even be expected to reach the water of the sound — see Table 4.4-2).

The scenario generating the greatest volume of oil would be a very unlikely catastrophic rupture of a crude oil storage tank, with 143,000 bbl of crude oil entering the water at the Valdez Marine Terminal (see Table 4.4-2). Fisheries and other marine and shoreline subsistence resources likely would be adversely affected by such a spill, even assuming relatively limited dispersal and rapid containment. The greatest impacts would be expected to occur close to shore in a relatively small area, thereby leaving open-water fisheries and the great majority of shallow-water and shoreline catchment areas generally unharmed. Such a spill should not have a large impact on sociocultural systems in the Prince William Sound area, because of the limited geographic impacts and the ability of peoples in the region relying on subsistence fishing, hunting and gathering, and commercial fishing to avoid the relatively confined impact area. Once again, however, some impacts might occur because of perceived dangers of consuming resources taken from near the spill area, even after scientific examinations have declared them safe — as occurred during the Exxon Valdez spill (see Fall 1999a) and possibly exacerbated by prior experience with that event. The impact of perceived damage to resources could extend beyond subsistence resources to commercial fisheries, thereby endangering a key component of the cash economy of both Alaska Native and rural non-Native sociocultural systems near the spill area. Duration of sociocultural impacts could vary with the sociocultural system concerned. If the Exxon Valdez spill experience was indicative of the type and duration of impacts under the large, *very unlikely* spill, many sociocultural impacts likely would not be large or last a long time (see Wooley 1995) despite the large negative effect on local economies.

Regardless of the likelihood of a spill or the major geographic setting where a release occurred, larger-volume events would require cleanup responses that might involve use of local labor — particularly in more isolated settings and in situations where communities (notably Alaska Native villages) already have a hiring commitment from APSC for such activities. Two types of impacts on sociocultural systems might accompany such cleanup activities. One is a possible impact caused by an influx of outsiders to a rural setting, introducing or further establishing ideas or behavior patterns originating in other sociocultural environments as well as exacerbating certain social problems, such as substance abuse and crime. The general familiarity of rural Alaskans with more modern settings (such as urban Alaska), coupled with the limited duration of cleanup activities for most of the spill scenarios considered here, likely would yield only small sociocultural impacts from the influx of nonlocal people and behavior patterns. In contrast, local involvement in cleanup activities would generate cash income, an important component in mixed rural economies and hence a positive impact for sociocultural systems accustomed to (and in many ways reliant upon) periodic infusions of cash. Again, the likely short duration of cleanup responses would mean that the cash introduced to local economies would be similarly limited, although its impacts in general would likely be positive.

4.4.4.16 Cultural Resources

Given the proximity of certain cultural resources to the pipeline and other TAPS components (such as the Valdez Marine Terminal), the potential exists for adverse impacts as the result of a spill. Although the uncertainty of possible spill locations and, in many cases, site characteristics, makes it impossible to establish with certainty the nature of those impacts, high-volume spills and those affecting large areas along portions of the pipeline close to cultural resources likely would damage such resources, possibly including sites listed on the National Register of Historic Places. The likelihood of such spills is very low (see Section 4.4.1), suggesting that overall risk to cultural resources would be similarly low. However unlikely, there is a potential for adverse impacts to cultural resources as the result of a major spill.

Impacts of Oil Spills on Cultural Resources

High-volume oil spills affecting large areas near either known or unreported cultural resources could damage those resources, possibly including sites listed on the National Register of Historic Places. However, because the projected frequency of spills large enough to cause major damage is low (less than once every 100 years), the overall risk to cultural resources would also be expected to be low.

Several specific locations were examined to establish the potential effect of a spill on key cultural resources. The nature and specific locations of the sites are protected under the Archaeological Resources Protection Act and thus cannot be provided in this document. Each of the four spill categories discussed in Section 4.4.1 — *anticipated*, *likely*, *unlikely*, and *very unlikely* — was considered. The effects of the various scenarios on cultural resources ranged widely, depending on the amount and location of the spill relative to a specific site. Location is the key factor for determining whether an adverse impact would occur for all scenarios. The magnitude of impacts was consistent for all categories except for the *anticipated* spills category, consisting of smaller-volume releases, for which the likelihood of a noteworthy impact is less. The smaller spills in this category generally would be confined to the ROW, where sites may exist but where the majority of past earthmoving activities during TAPS construction and maintenance were concentrated — increasing the possibility that the sites have been heavily disturbed.

Analyses of the other three spill categories found that noteworthy impacts were possible under certain conditions. If a spill occurred upslope from an archaeological site or traditional cultural property, the possibility of damaging the site increased, while a spill downslope from a site decreased the likelihood of an impact.

If a spill actually involved a cultural resource, two types of damage would be possible. One would involve oil coming in contact with archaeological material, which could destroy some types of archaeological information, such as that obtained by radiocarbon dating or floral analysis, and/or increase the deterioration of an object or structure. The second type of impact would involve disturbance from containment and remediation activities, such as from driving heavy machinery through the site, ditching for containment, soil removal, and similar operations. Such activities could destroy part or all of a site or a traditional cultural property. Impacts to historic structures are unlikely, but could potentially occur during containment and remediation activities such as those listed above.

In the case of spills affecting cultural resources, a Programmatic Agreement (DOI et al. 1997) in place since 1997 creates a special situation not found in other issue areas. This agreement states that cultural resources will not be considered during spill containment on dock staging areas less than 50 years old; gravel, paved, or graded roads; parking areas; causeways; airport runways; or drilling mats. The agreement requires that area contingency plans be in place detailing the procedure for contacting an archaeologist and assessing the impact of a spill and the resulting cleanup on historic properties, taking into consideration areas covered by exclusions and conditions for revoking exclusions. Exclusions can be revoked if a spill is greater than 100,000 gal or if the SHPO indicates that a historic property will be affected by the spill. APSC has spill contingency plans in place (APSC 2001g) and has contracted an archaeologist who would be contacted in the event of an emergency, thereby meeting the requirements of the Programmatic Agreement.

4.4.4.17 Land Uses and Coastal Zone Management

Continued operation of the pipeline entails the risk of land or water-based oil spills that could potentially affect land use and coastal zone management.[9] The severity of the impact would be largely determined by the volume, location, duration, and time of year of the spill. Twenty-one spill scenarios have been developed for the proposed action and are presented in Table 4.4-1. The scenarios are categorized by frequency range, which include anticipated, likely, unlikely, and very unlikely. Frequencies are calculated for the pipeline as a whole; therefore, the probability of a spill occurring at a specific point along the pipeline or within a specific area crossed by the pipeline is substantially less. The scenarios discussed

9 Separate spill scenarios have been developed for the Valdez Marine Terminal and are discussed below.

below represent the greatest potential release of oil for each frequency range.

An anticipated scenario, expected to occur at some point along the pipeline one or more times every two years, is an instantaneous release of 50 bbl of crude oil caused by a pipeline leak (Scenario 1). For a land-based spill, about seven-hundredths of an acre would be covered one inch deep, which would equal a circle roughly 60 ft in diameter. For a water-based spill, this volume of oil would produce contamination problems downstream.

Spill scenarios likely to occur (Scenarios 12 and 14) would involve a prolonged pipeline leak (potentially lasting for days) due to sabotage, vandalism, or corrosion-related damage. The maximum amount of crude oil spilled would be 10,000 bbl and for a land-based spill would cover about 15 acres at a depth of 1 in. For a water-based spill, this volume would produce a lengthy slick. A likely scenario is one estimated to occur somewhere along the pipeline once every 2 to 30 years.

The greatest impact on land use would be from a spill caused by a fixed aircraft crash (Scenarios 19a and 19b, without and with a fire, respectively) or helicopter crash (Scenario 21) into the pipeline that resulted in a guillotine break. For one of these events, a maximum of 54,000 bbl of crude oil would be released over a period of hours. For a land-based spill, this volume of oil would cover about 84 acres at a depth of 1 in. The aircraft crash could also result in a fire (Scenario 19b). For a water-based spill, this volume of oil could result in an oil slick almost 13 mi long and could affect shoreline areas where oil washed ashore. A guillotine break from an aircraft crash, with or without fire, is unlikely and is estimated to occur once in 30 years to once in 1,000 years somewhere along the pipeline. A guillotine break from a helicopter crash is very unlikely, with an estimated probability of occurring at some point along the pipeline between once in 1,000 years and once in 1,000,000 years.

4.4.4.17.1 Land Uses. A variety of land uses occur in the vicinity of the TAPS that could be affected by a spill, including recreation, wildlife habitat and other natural resource conservation, commercial, municipal, residential, agricultural, Native corporations, subsistence activities, and military reservations.

> **Impacts of Oil Spills on Land Use**
>
> All of the spill scenarios evaluated in this section would result in immediate and potentially long-term land use impacts, with the severity largely determined by the volume, duration, location, and time of year of the spill. Both the spill and cleanup activities could potentially interfere with existing land uses in the area. These uses include recreation, wildlife habitat and other natural resource conservation, commercial, municipal, residential, agricultural, Native corporations, and military reservations.

Land-Based Spills. In all of the scenarios, the number of acres actually impacted by a land-based spill would depend on the type of geology, soils, topography, and vegetation present in the spill area. If a fire occurred as a result of an aircraft crash into the pipeline, additional acres beyond the spill area could be directly affected. Air quality would also be temporarily affected in the spill area, as well as downwind, because of smoke and airborne ash. Areas in the vicinity of the spill would likely be evacuated, thereby disrupting normal activities. If any of the above-listed scenarios occurred in proximity to surface water, impacts to that resource would be likely because of overland flow of the oil into the water, resulting in lengthy cleanup activities (see Section 4.4.4.3).

All of the spill scenarios evaluated here would result in immediate and potentially long-term land use impacts, with the severity largely determined by the volume, duration, location, and seasonal occurrence of the spill. The aesthetic quality of the area would be diminished because of visible oil, damaged vegetation, and the presence of personnel and machinery during cleanup. Visual effects would be evident until revegetation occurred. Cleanup activities would be noisy and likely dusty and could last weeks, months, or years, depending on spill volume. Both the spill and cleanup activities could potentially interfere with existing land uses.

A spill could have a long-term impact on recreational resources and opportunities, particularly if it were within or near a park or recreation area or site. Several recreational parks, areas, or sites are within 1 mi of the TAPS and could be directly or indirectly affected by a spill. Potential recreational impacts are discussed in Section 4.4.4.18.1.

Some lands set aside for wildlife habitat conservation (as well as other purposes) could be either directly or indirectly affected by a spill, including ACECs, national wildlife refuges, and national parks. Four ACECs within 2 mi of the pipeline are protected for critical wildlife habitat: Galbraith Lake, Snowden Mountain, Nugget Creek, and Jim River. In the event of a spill, these ACECs could be indirectly affected by noise from cleanup activities. A small portion of the western boundary of the ANWR comes within 0.25 mi of the pipeline and part of the western boundary of Yukon Flats NWR comes within 2 mi of the pipeline. Neither refuge would be directly affected by a spill, including a guillotine break, because of their relatively long distance from the pipeline. Even the portion of the ANWR that is closest to the TAPS would likely not be affected by a major spill because of the topography of the area, which slopes away from the refuge. A guillotine break caused by an aircraft crash into the pipeline that resulted in a fire could potentially affect both refuges, depending upon the extent of the fire, but this is unlikely (see above). Both could be indirectly affected by noise from cleanup activities. The Kanuti NWR, which is 8 mi west of the TAPS at its closest point, would not be directly or indirectly affected by a land-based pipeline spill. Noise from cleanup activities might be audible within Gates of the Arctic NPP, which is 2 to 3 mi from the pipeline at its closest point, and from the small portion of Wrangell-St. Elias NPP that comes within 2 mi of the pipeline.

A guillotine break spill that occurred near a municipal, residential, commercial, or agricultural area would temporarily interfere with those land uses. An aircraft crash into the pipeline resulting in a fire would cause the greatest impact, potentially resulting in temporary evacuation of the area, destruction of private property, and interference with activities. Cleanup activities would also be disruptive. However, occurrence of such an event is unlikely. A likely spill of 10,000 bbl could result in some temporary disruption of land use, but an anticipated scenario involving a release of 50 bbl of oil would have a minimal effect on commercial, municipal, or residential land use, but a somewhat greater effect on agriculture. However, these land uses rarely occur near the pipeline along its 800-mi length. In addition, the pipeline is often below ground in commercial, municipal, residential, and agricultural areas.

Land owned by Native corporations is used primarily for subsistence hunting. A discussion of the effects of spills on subsistence is provided in Section 4.4.4.14.

A guillotine break spill that occurred on or near a military reservation would temporarily interfere with land use. An aircraft crash into the pipeline resulting in a fire would cause the greatest impact, resulting in temporary evacuation of the area, potential destruction of military property, and interference with military activities. Cleanup would also be disruptive and could interfere with military activities on a long-term basis. However, occurrence of such an event is unlikely. A likely spill scenario involving release of 10,000 bbl of oil could result in temporary disruption of military activities, but an anticipated scenario involving a release of 50 bbl of oil would be much less likely to result in disruption. Eielson AFB, Fort Greely, and Fort Wainwright are all crossed by the pipeline and would be directly affected by any spill along portions of the pipeline crossing those reservations.

A major spill at the Valdez Marine Terminal would disrupt other land uses within the Valdez coastal zone. These scenarios are discussed below in Section 4.4.4.17.2.

In spite of the realm of potential spills and associated environmental impacts that could occur, historical data indicate that most land-based oil spills in the vicinity of the TAPS have been relatively small. Temporary impacts to land use have occurred from past spills.

Water-Based Spills. Any of the scenarios described above for water-based spills could result in immediate and long-term land use impacts. Initially, an oil slick would form on the river, oil would be visible on the shoreline, and shoreline vegetation would be damaged and/or killed. Cleanup activities, which could be long term, would be noisy and disruptive, and could temporarily prohibit other activities in the vicinity of the spill. A water-based spill, particularly a guillotine break directly into a river, would likely have a long-term impact on water-related recreational activities, including floating, boating, sport fishing, and shoreline camping. Potential impacts are discussed in Section 4.4.4.18.1.

The Kanuti NWR could be affected by a water-based spill. A guillotine break along the Koyukuk River near MP 245 would cause oil to flow almost directly into the river and potentially reach the refuge. An oil slick would form on the river, fisheries would be affected, and shoreline vegetation would be damaged and/or killed. Cleanup activities would disturb and possibly temporarily displace wildlife. Subsistence activities within the refuge would likely be affected, at least temporarily. See Section 4.4.4.3 for a discussion of spill impacts to surface water, Sections 4.4.4.8 through 4.4.4.12 for impacts to biological resources, and Section 4.4.4.14 for impacts to subsistence.

Native corporation land is used primarily for subsistence hunting. See Section 4.4.4.14 for a discussion of the effects of a water-based spill on subsistence activities.

Activities on military reservations could be disrupted by a water-based spill, with Eielson AFB most likely to be affected if a water-based spill occurred in a portion of the pipeline crossing the base. The TAPS crosses a number of creeks as well as Little Salcha River as it passes through a large portion of Eielson AFB, and the pipeline is aboveground for the majority of its length through the base. The pipeline is belowground as it crosses a small portion of Fort Greely and Fort Wainwright, reducing the likelihood that military activities on either of those reservations would be disrupted by a water-based pipeline spill. However, a large volume pipeline spill nearby could potentially reach any of these military reservations because of the number of creeks, rivers, and tributaries in the vicinity.

For any water-based spill, the length of the oil slick would depend on the velocity of the river, duration of the spill, location of the spill in relation to the nearest containment site, and the rapidity of the spill response. Historical data indicate that few spills into rivers have occurred since TAPS construction.

4.4.4.17.2 Coastal Zone Management. A land- or water-based pipeline spill could potentially affect either the North Slope Borough or Valdez coastal zones. Both the North Slope Borough and Valdez CMPs recognize this risk and require oil spill prevention and response plans (see Section 4.1.4), which are also subject to statewide ACMP standards. The North Slope Borough CMP also requires risk analyses for various spill scenarios. The TAPS is in compliance with these requirements.

Impacts of Oil Spills on Coastal Zone Management

All of the spill scenarios evaluated in this section could result in immediate and potentially long-term coastal zone impacts, with the severity largely determined by the volume, duration, location, and time of year of the spill. The spills would not be likely to substantially interfere with terrestrial subsistence activities or resources within the North Slope Borough coastal zone, although a water-based spill could at least temporarily impact those activities and/or resources. Spills within the Valdez coastal zone could disrupt other land use activities in the area or impact Prince William Sound.

The pipeline spill scenarios evaluated were chosen from the 21 scenarios presented in Table 4.4-1 and outlined above. The Valdez Marine Terminal scenarios discussed below were chosen from the 12 scenarios summarized in Table 4.4-2. The scenarios in both tables are categorized by frequency ranges, which include anticipated, likely, unlikely, and very unlikely. Frequencies are calculated for the pipeline as a whole and the probability of a spill occurring at a specific point along the pipeline is substantially less. Each scenario discussed below represents the greatest potential release of oil for that frequency range. The severity of the impact would be largely determined by the volume, location, duration, and season of occurrence of the spill.

Most of the pipeline is below ground within the North Slope Borough coastal zone. All but a small segment near the Valdez Marine Terminal is below ground within the Valdez coastal zone.

North Slope Borough Coastal Zone. The *anticipated*, *likely*, *unlikely*, and *very unlikely* scenarios discussed above would also apply to the North Slope Borough coastal zone along the aboveground portion of the pipeline. Because the pipeline runs below the ground through most of the North Slope Borough coastal zone, most other potential land-based spills would involve a belowground release of oil. The anticipated scenario (Scenario 1) and likely scenario (Scenario 14) described above could also occur as belowground releases along the buried portion of the pipeline. An unlikely scenario (Scenario 16), which could occur along the buried portion of the pipeline and result in an underground release, is described below under the Valdez CMP. Any of these belowground spills could result in surface water or groundwater contamination (see Sections 4.4.4.3 and 4.4.4.4), but direct spills to surface water would be improbable.

All of the above- or belowground land-based spill events could result in immediate and potentially long-term impacts to coastal resources and disrupt other activities within the coastal zone. The severity of the impacts would depend largely on the volume, duration, location, and season of occurrence of the spill. The spills would not be likely to substantially interfere with terrestrial subsistence activities within the North Slope Borough coastal zone or jeopardize the continued availability of terrestrial subsistence resources. See Sections 4.4.4.8 through 4.4.4.12 for discussions of spill impacts on biological resources and Section 4.4.4.14 for a discussion of impacts on subsistence.

The number of acres actually impacted by each type of spill would depend on the type of geology, soils, topography, and vegetation present in the spill area. If a fire occurred as a result of an aircraft crash into the pipeline, additional acres beyond the spill area could be directly affected, dependent upon the extent of the fire. Cleanup activities could last weeks, months, or years. Overland flow of oil could also result in impacts to surface water and necessitate additional cleanup activities (see below).

Direct spills to surface water would also cause immediate and potentially long-term impacts to the North Slope Borough coastal zone. The length of the resulting oil slick would depend on the velocity of the river, duration of the spill, location of the spill in relation to the nearest containment site, and season of occurrence. A complete discussion of spills to surface water is presented in Section 4.4.4.3.

Even a relatively small spill, such as the 50 bbl release under the “anticipated” release scenario, would likely affect aquatic resources and activities, at least temporarily. The severity of the impacts would depend on the spill volume, duration, location, and season of occurrence.

Under the *unlikely* and *very unlikely* scenarios, a guillotine break in the pipeline along the Sagavanirktok River (within the North Slope Borough coastal zone) resulting in release of up to 54,000 bbl of oil would result in oil flowing almost directly into the river. Effects to fisheries could result in impacts to subsistence resources and/or activities, at least temporarily. However, the probability of such an event occurring on the Sagavanirktok River within the North Slope Borough coastal zone is substantially less than the overall probability of occurrence along the entire pipeline.

Valdez Coastal Zone. The *anticipated* and *likely* scenarios evaluated for the Valdez coastal zone were generally the same as those evaluated for the North Slope Borough coastal zone and land use in general. They would result in an above- or belowground release of 50 bbl and 10,000 bbl of oil, respectively.

An *unlikely spill* (Scenario 16) would be a crack caused by seismic activity resulting in a short-term (hours), belowground release of 16,000 bbl of oil. The probability of this type of spill occurring is once in 30 years to once in

1,000 years anywhere along the pipeline, with substantially less likelihood of occurring specifically with the Valdez coastal zone.

The greatest impact to the Valdez coastal zone from a land-based spill would occur from an aircraft crash into the crude oil tank at the East Tank Farm of the Valdez Marine Terminal, resulting in a fire and the prolonged (over a number of days) release of 382,500 bbl of oil (Scenario 10 from Table 4.4-2). This spill scenario is *very unlikely*, but if it did occur, this spill would disrupt other activities within the Valdez coastal zone, at least temporarily. Air quality would be temporarily affected in the spill area and downwind because of smoke and airborne ash. Surrounding areas would likely be evacuated until the fire was extinguished. Cleanup activities would be noisy and could last weeks, months, or years. However, because of containment measures, this type of spill would not be expected to reach Prince William Sound (Table 4.4-2).

Because the pipeline runs below ground throughout the Valdez coastal zone except for a small segment at the Valdez Marine Terminal, most other potential land-based spills would involve a belowground release of oil. This type of spill could result in surface water or groundwater contamination (see Sections 4.4.4.3 and 4.4.4.4), but direct spills to surface water other than Prince William Sound would be improbable (see below). Cleanup activities for any of the underground releases discussed could be extensive and long-term, resulting in at least temporary disruption of other activities in the Valdez coastal zone.

A direct spill to Prince William Sound could result from the catastrophic rupture of a crude oil storage tank at the Valdez Marine Terminal (Scenario 11 from Table 4.4-2). In this scenario, a total of 193,800 bbl of oil could be released instantaneously and 143,450 bbl could reach Prince William Sound. Up to 2 mi of shoreline within the Port of Valdez could be impacted, depending upon spill response time and current and wind speeds at the time of the spill. Other activities within the coastal zone could be disrupted by shoreline cleanup activities at least temporarily. However, this type of catastrophic spill is very unlikely to occur.

As discussed above, all but a small portion of the pipeline is below ground within the Valdez coastal zone. Therefore, other than the remote possibility of a catastrophic spill at the Valdez Marine Terminal that releases oil to Prince William Sound, there is very little probability that a direct spill to surface water from the pipeline would occur within the Valdez coastal zone.

4.4.4.18 Recreation, Wilderness, and Aesthetics

Continued operation of the pipeline would entail the risk of a land- or water-based oil spill that could potentially affect recreation or wilderness resources, or aesthetics. The severity of the impact would be determined largely by the volume, duration, location, and season of occurrence of the spill. Twenty-one spill scenarios have been developed for the proposed action and are presented in Table 4.4-1. The scenarios are categorized by frequency range as follows: anticipated, likely, unlikely, and very unlikely. The scenarios discussed below represent the greatest potential release of oil for each frequency range. Frequencies are calculated for the pipeline as a whole; therefore, the probability of a spill occurring at a specific point along the pipeline is substantially less. Spills occurring near, in, or visible from, a public road (e.g., Dalton Highway); river (particularly a Wild and Scenic River); ACEC; Wilderness Area; or national or state park, recreation area, or site would have the most substantial impact on recreation resources, wilderness, and aesthetics. Because sight-seeing is such a popular recreational activity in Alaska, any impact to aesthetics also represents an impact to recreation.

For this analysis, an anticipated scenario, which is an event expected to occur one or more times every 2 years, is an instantaneous release of 50 bbl of crude oil caused by a pipeline leak (spill Scenario 1). In case of land-based spill, about seven-hundredths of an acre would be covered 1 in. deep, which would equal a circle about 60 ft in diameter. For a water-based spill, this volume could produce contamination problems downstream.

Spill events likely to occur (Scenarios 12 and 14) would involve a prolonged pipeline leak (lasting for days) caused by sabotage, vandalism, or corrosion-related damage. The maximum amount of crude oil spilled would be 10,000 bbl and for a land-based spill would cover about 15 acres at a depth of 1 in. For a water-based spill, this volume could result in a lengthy downstream oil slick. A likely scenario is one estimated to occur between once in 2 years and once in 30 years.

The greatest impacts would occur from a helicopter crash (Scenario 21) or fixed-wing aircraft crash (Scenarios 19a or 19b, with and without fire, respectively) into the pipeline that resulted in a guillotine break and that occurred near or at a designated recreation or wilderness area or other area of aesthetic value (see Table 3.27-1). For both an aircraft crash and a helicopter crash, a maximum of 54,000 bbl of crude oil would be released over a period of hours and for a land-based crash would cover about 84 acres at a depth of 1 in. If it occurred on land, the aircraft crash could also result in a fire (Scenario 19b).

If the guillotine break occurred directly into a river, a release of 54,000 bbl of oil could produce an oil slick almost 13 mi long and cause recreational and aesthetic impacts. A guillotine break from an aircraft crash, with or without fire, is unlikely and is estimated to occur once in 30 years to once in 1,000 years. A guillotine break from a helicopter crash is very unlikely, with an estimated frequency of between once in 1,000 years and once in 1,000,000 years.

4.4.4.18.1 Recreation. All the spill scenarios described above would result in immediate and potentially long-term recreational impacts if they occurred at or near a designated recreation area. The aesthetic quality of the area would be degraded because of visible oil, damaged vegetation, and the presence of personnel and machinery during cleanup. Cleanup activities would be noisy and likely dusty, and could last weeks, months, or years, depending on spill volume. The quality of the recreational experience in the vicinity of the spill would be substantially reduced until remediation efforts were completed, and visual effects would be evident until revegetation occurred. Use of the recreation resources in the vicinity of the spill could be temporarily lost if the spill resulted in closure of an area. Consequently, even a low-volume spill within the likely or anticipated frequency range could have a substantial effect on recreation resources, particularly if it were within or near a park or a designated recreational area or site. Several recreational parks, areas, or sites are within 1 mi of the TAPS and could be directly or indirectly affected by a spill.

Impacts of Oil Spills on Recreation

All of the spill scenarios described above would result in immediate and potentially long-term recreational impacts if they occurred near or at a designated recreation area. The quality of the recreational experience in the vicinity of a land- or water-based spill would be substantially reduced by the visual effects of the spill and the noise from cleanup activities. This situation would continue until remediation efforts were completed. Use of the recreation resources in the vicinity of the spill could be temporarily lost if the spill resulted in closure of an area. Several recreational parks, areas, or sites are within 1 mi of TAPS and would be directly or indirectly affected by a spill. A spill into a river would prohibit water-based activities, at least temporarily, until initial containment and cleanup activities were complete.

A guillotine break spill, with or without fire, would be particularly damaging to recreation if it occurred at a popular tourist attraction such as Worthington Glacier State Recreation Site (SRS), which is crossed by the pipeline. A high-volume spill would be particularly visible at this SRS and would likely reach the surface water at the base of the glacier because of the topography of the area. Cleanup activities would be extensive and long-term and would likely require temporary, but potentially long-term, closure of the SRS, resulting in loss of use of the recreational resources at the site for the duration of the closure.

Land-Based Spill. For all the scenarios, the number of acres actually impacted by a land-based spill would depend on the type of geology, soils, topography, and vegetation present in the spill area. If a fire occurred as a result of an aircraft crash into the pipeline, additional acres beyond the spill area could be directly affected, depending on the extent of the fire. Air quality would also be temporarily affected in the spill area, as well as downwind, because of smoke and airborne ash. Recreational areas in the vicinity of the spill would be evacuated, thereby disrupting activities. If any of the spill events occurred near surface water, impacts to that resource would be likely because of overland flow of the oil, which would result in additional visual and recreational impacts and lengthy cleanup activities (see Section 4.4.4.3).

In spite of the realm of potential spills and associated environmental impacts that could occur, historical data indicate that most land-based oil spills in the vicinity of the TAPS have been relatively small. Environmental effects have been localized and temporary and have not resulted in long-term impacts to recreation resources. In addition, most spills have not been visible to visitors except by air.

Water-Based Spills. All the spill scenarios described above could result in immediate and long-term impacts on water-based recreation if the spills occurred directly into water. The severity of the impacts would be largely determined by the volume and location of the spill. Initially, an oil slick would form on the river, oil would be visible on the shoreline, and shoreline vegetation would be damaged and/or killed. Recreational activities on or along the river, such as floating, boating, sport fishing, or shoreline camping, would be prohibited at least temporarily until initial containment and cleanup activities were complete. Cleanup could be long-term, as could the aesthetic effects on the shoreline and impacts to sport fishing. See Sections 4.4.4.3 and 4.4.4.10 for discussions of spill impacts to water resources and fish, respectively.

In particular, an oil spill in a popular recreational river such as the Gulkana or Tanana could have substantial impacts. The pipeline crosses both rivers on elevated bridges, and both rivers are adjacent to the Richardson Highway and, thus, are highly visible. Both rivers are very popular with boaters, and floating is particularly popular on the Gulkana. The pipeline crosses the Tanana River at a popular put-in point, and crosses the Gulkana downstream of Sourdough Campground, which is a popular take-out point for floaters and a put-in point for powerboaters.

The Gulkana River is also a federally designated Wild River, protected for its beauty and pristine condition. A guillotine break in the pipeline where it crosses the Gulkana would be particularly damaging to its aesthetic qualities and would destroy its pristine quality — at least temporarily. Long-term ecological impacts such as damage to sport fisheries or destruction of shoreline vegetation would result in long-term recreational impacts.

For all the scenarios, the length of the oil slick would depend on the velocity of the river, duration of the spill, and location of the spill in relation to the nearest containment site. Historical data indicate that few spills into rivers have occurred since construction of the TAPS, and recreational effects have been short-term. A complete discussion of spills to surface water is presented in Section 4.4.4.3.

4.4.4.18.2 Wilderness. The only federally designated Wilderness in the vicinity of the TAPS is within the Gates of the Arctic NPP. No state-designated Wilderness exists near the pipeline. Historical data indicate that no land- or water-based spills have affected the Gates of the Arctic NPP Wilderness Area since construction of the TAPS.

It is very unlikely that a land-based TAPS spill would directly affect the Wilderness Area within Gates of the Arctic NPP (between MP 139 and 266) because the easternmost boundary of the area is 2 to 3 mi from the TAPS at its closest point. Impacts on the Wilderness Area from a water-based spill are also very unlikely because of the way surface waters flow near the area.

Impact of Oil Spills on Wilderness

It is very unlikely that a land-based TAPS spill would directly affect the federally designated Wilderness Area within the Gates of the Arctic NPP because the easternmost boundary of the area is 2 to 3 mi from TAPS at its closest point. Impacts on the Wilderness Area from a water-based spill are also very unlikely because of the way surface waters flow near the area. Only a large-volume spill into the Koyukuk River near MP 245 would be likely to reach the Wilderness Area, where the Koyukuk flows west along its southeastern boundary. Wilderness values would be affected if such a spill occurred.

Land-Based Spills. For a small spill such as covered by the *anticipated* spill scenario, the area affected would be small and the potential for cleanup activities to be heard from the wilderness area would be very low. For a *likely* spill event releasing 10,000 bbl, cleanup activities might be audible from eastern ridgelines within the Wilderness Area.

For land-based guillotine breaks in the pipeline caused by the crash of a helicopter or aircraft between MP 139 and 266, cleanup activities would be extensive and could require months or years to complete. Noise from the actual crash and cleanup activities might be heard from eastern ridgelines within the Gates of the Arctic Wilderness Area. If the aircraft crash resulted in a fire, smoke would likely be visible from the wilderness. An extensive fire could result in evacuation of the area. It is very doubtful that the spill or any related visual effects, including cleanup activities, could be seen from the Gates of the Arctic Wilderness Area.

Water-Based Spills. A water-based spill along the pipeline would be very unlikely to affect the Gates of the Arctic Wilderness Area unless the spill occurred at MP 245 near the Koyukuk River. Only a large-volume spill could potentially reach the Wilderness Area via water. A guillotine break (caused by a aircraft or helicopter crash into the pipeline) along the Koyukuk River near MP 245 would result in oil flowing almost directly into the river. The oil slick would likely reach the Wilderness Area, where the Koyukuk flows west along its southeastern boundary.

If spilled oil did reach the Gates of the Arctic Wilderness Area via the Koyukuk River, the wilderness values within a localized portion of the Wilderness Area could be affected. The severity of the impacts would depend on the amount of oil that actually reached the area via the river. An oil slick would be visible on the river, and oil would likely be visible on the shoreline. Shoreline vegetation would likely be damaged and/or killed. Cleanup activities would involve machinery and personnel and would be noisy and potentially long term. Visual effects would be evident until remediation efforts were completed and shoreline revegetation occurred. Recreational activities on or adjacent to the river would likely be prohibited at least temporarily. In short, the wilderness qualities along this portion of the Koyukuk River would be substantially affected. The area would no longer be untrammeled by man, and opportunities for solitude and unconfined recreation in this portion of the Gates of the Arctic Wilderness Area would be unavailable at least temporarily.

4.4.4.18.3 Aesthetics. A land- or water-based pipeline spill could potentially affect visual resources in the vicinity of the pipeline, with the severity of the aesthetic impact largely determined by the volume, duration, location, and season of occurrence of the spill. Spills occurring near, in, or visible from a public road;

Impact of Oil Spills on Aesthetics

A land- or water-based pipeline spill would have the potential to affect visual resources in the vicinity of the pipeline, with the severity of the impact largely determined by the volume, duration, location, and season of occurrence of the spill. Spills occurring near, in, or visible from a public road; pipeline viewing station; river (particularly a Wild and Scenic river); area of critical environmental concern; Wilderness Area; or national or state park, recreation area, or site would have the greatest impact on aesthetics.

pipeline viewing station; river (particularly a Wild and Scenic River); ACEC; Wilderness Area; or national or state park, recreation area, or site would have the most substantial impact on aesthetics.

Land-Based Spills. All of the spill scenarios described above could result in immediate and long-term aesthetic impacts, with the severity largely determined by the volume and location of the spill. Initially, oil would be visible, and dead or damaged vegetation would be apparent. During cleanup, which could last weeks, months, or years, depending on spill volume, vegetation would be denuded, soil would be removed, and personnel and machinery would be on-site. Effects from the spill would be visible until remediation efforts were completed and revegetation occurred.

A guillotine break spill, with or without fire, would be particularly damaging to aesthetics if it occurred at a popular tourist attraction such as Worthington Glacier SRS, which the pipeline crosses. A high-volume spill would be particularly visible at this SRS and would likely reach the surface water at the base of the glacier because of the topography of the area. Cleanup activities would be extensive and long-term and could result in long term visual degradation of the site.

For all the scenarios, the number of acres actually affected would depend on the type of geology, soils, topography, and vegetation present in the spill area. If a fire occurred as a result of the aircraft crash, additional acres would likely be directly affected, depending on the extent of the fire. Air quality would also be temporarily affected in the spill area as well as downwind because of smoke and airborne ash. If any of these spill events occurred near surface water, impacts to that resource would be likely because of overland flow of the oil, resulting in an additional aesthetic impact. Cleanup efforts for surface water could also entail months or years of effort (see Section 4.4.4.3).

In spite of the realm of potential spills and associated environmental impacts that could occur, historical data indicate that most land-based oil spills in the vicinity of the TAPS have been relatively small. Environmental effects have been minor, localized, and temporary. In addition, most spills have not been visible to visitors except by air.

Water-Based Spills. If they released oil into water, all the spill events discussed above could result in immediate and long-term aesthetic impacts, with the severity largely determined by the volume, duration, and location of the spill . Initially, an oil slick would be visible on the river, and oil would be visible on the shoreline. Shoreline vegetation would be damaged and/or killed. During cleanup, which could last weeks, months, or years depending on spill volume, personnel and machinery would be on-site, and shoreline vegetation would be trampled and likely denuded. Effects from the spill would be visible until remediation efforts were completed and the shoreline was revegetated.

Oil spills to rivers such as the Gulkana, Tanana, or Yukon would be particularly noticeable to the public because they are crossed by, or adjacent to, public highways. In addition, these rivers, as well as several others in the vicinity of the TAPS, are used for a variety of recreational activities and are very visible to large numbers of people. In particular, any spill to the Gulkana River would have particularly noticeable aesthetic impacts because it is a federally designated Wild River, protected for its beauty and pristine condition. A guillotine break in the pipeline where it crosses the Gulkana would be particularly damaging to the river's aesthetic qualities.

For all the spill scenarios, the length of the oil slick would depend on the velocity of the river, duration of the spill, and location of the spill in relation to the nearest containment site. Historical data indicate that few water-based spills have occurred since construction of the TAPS, and aesthetic effects have been minor. A complete discussion of spills to surface water is presented in Section 4.4.4.3.

4.4.4.19 Environmental Justice

As did the assessment of impacts on minority and low-income populations under the proposed action and alternatives, the assessment of environmental justice impacts on these populations from accidents requires an assessment of effects in other impact areas to identify any that are high and adverse. Those areas expected to experience high and adverse impacts, in turn, are examined to determine how they affect environmental justice populations.

In general, this DEIS considers the consequences of spills for all impact areas under four probability categories: *anticipated* (>0.5/yr), *likely* (0.03 to 0.5/yr), *unlikely* (10^{-3} to 0.03/yr), and *very unlikely* (10^{-6} to 10^{-3}/yr) — with accompanying estimates of spill volumes. As discussed in Section 4.4.1, spill volumes (and hence impacts) tend to increase as probability decreases — such that *unlikely* and *very unlikely* spill scenarios tend to have the greatest potential to do the most damage. For purposes of assessing the impacts of spills on environmental justice, this evaluation considered the entire range of impacts that were examined for each impact area — because smaller, more frequent spills occasionally lead to high and adverse impacts (e.g., for groundwater, see Section 4.4.4.4). Although spills of oil, diesel fuel, and other materials associated with the movement of oil through the TAPS by definition yield adverse impacts, the majority of consequences from spills are anticipated to be small and short term. On the basis of an evaluation of the anticipated consequences of spills that might occur at specific locations and under particular conditions during the continued operation of the TAPS, described throughout Section 4.4.4, eight impact areas would experience impacts that can be interpreted as high and adverse:

- Surface water;
- Groundwater;
- Human health and safety;
- Fish;
- Birds and terrestrial mammals;
- Subsistence;
- Sociocultural systems; and
- Recreation, wilderness, and aesthetics.

Environmental Justice Impacts Related to Oil Spills

Depending on the exact circumstances, TAPS-related spills could result in the following impacts that could affect environmental justice populations:

- Surface Water: Possible constraints on transportation along navigable waterways and impacts to subsistence fisheries (see below)
- Groundwater: Possible need for alternatives to wells as sources of water
- Human Health and Safety: Possible impacts from inhalation of contaminants emitted from spills or fires in communities closer than 4 km to the TAPS
- Fish: Possible severe negative impacts from large *unlikely* and *very unlikely* spills into a river
- Birds and Terrestrial Mammals: Possible high negative impacts from a large spill that affects a large concentration of birds or mammals
- Economics: Possible positive impact on employment of members of minority and low-income groups in spill cleanup operations
- Sociocultural: Possible short- or long-term modification of economic bases, because of impacts on riverine subsistence fisheries
- Subsistence: Possible short- or long-term destruction (or substantial reduction) of riverine subsistence fisheries
- Recreation and Aesthetics: Possible impacts to the Gulkana National Wild River

Table 4.4-39 provides a summary of impacts in these and other impact areas due to spills. The following paragraphs discuss anticipated high and adverse impacts in greater detail, particularly in the context of environmental justice.

Impacts to surface water depend on the size of spill and the nature of the body of water where the spill occurs. As discussed in Section 4.4.4.3, the TAPS crosses about 800 streams and rivers over the length of the pipeline. For a spill of a given volume, shallower, slower-moving streams and rivers generally would experience larger impacts. Impacts to humans could include constrained transportation (on navigable streams and rivers), human health and safety, subsistence (emphasizing riverine resources), and recreation and aesthetics. Possible consequences for the last three impact areas are examined in the paragraphs below.

Impacts to movement along rivers and streams would be limited to those water bodies experiencing a spill of sufficient volume to hinder travel by boat. As shown in Figures 3.29-1 and 3.29-2, and in Table 3.29-1, disproportionately high percentages of minority and low-income populations occur throughout much of the area where the TAPS passes and in many of the nearby communities. These areas of disproportionately high minority and low-income populations also include several navigable rivers. The oil slicks described in Table 4.4-15 on only two of the six example rivers and streams considered would approach populated places — spills on the Tanana River (reaching river locations near Fox, Fairbanks, College, and Ester) and on the Tazlina River (reaching river locations near Copper Center, Copperville, Kenny Lake, and Tazlina). However, in certain times of the year, virtually any of the navigable waterways crossed by the TAPS might be supporting human movement, and because of the demographic characteristics of the area described in Section 3.29, a spill might affect travel by members of minority or low-income populations more than members of the population as a whole. All this stated, the probability of a large spill in any particular waterway is remote — for example, on the order of 1 chance in 255 million for a 300-ft river crossing (see Section 4.4.4.3) — greatly reducing the overall risk of spill impacts to surface water. Moreover, quick, targeted spill response could limit the impacts of such a spill considerably, thereby reducing effects to environmental justice populations.

The effects of a spill on groundwater also could be high and adverse, even for a comparatively smaller routine spill under the *likely* probability category (see Section 4.4.4.4). In cases where people draw water from wells, spills that affect groundwater could restrict well use or adversely affect human health if contaminated water continued to be used. Well use is greater outside of urban areas, where municipal water systems are unavailable; the vast majority of the area crossed by the TAPS consists of these rural areas.

Because much of the area in geographic proximity to the TAPS and many of the communities examined here occur in areas lacking municipal water and contain disproportionately high percentages of minority and low-income persons (see Figures 3.29-1 and 3.29-2 and Table 3.29-1), it is likely that groundwater impacts from a spill could have disproportionately high and adverse effects on one or both environmental justice populations. Regulatory guidelines guard against human use of contaminated water, thereby providing a type of protection from negative effects of groundwater impacts on human health (see Section 4.4.4.7). However, the need to obtain an alternative source of water should groundwater become contaminated would persist for those localities affected. Sufficiently detailed, site-specific information on local groundwater is not available to make it possible to specify which communities would have their water supplies affected by a spill. However, as shown in Figure 3.25-1 several communities are located near the TAPS and presumably their groundwater resources could become contaminated by a spill. Rapid response once again could help limit the magnitude of impacts to groundwater in general and environmental justice impacts in particular.

Most impacts to human health and safety from spills are not anticipated to generate high and adverse impacts, regardless of the amount of contaminant released or the probability of

TABLE 4.4-39 Summary of Anticipated Impacts under Spill Scenarios

Issue Area	DEIS Section	Summary of Impacts[a]
Soils and permafrost	4.4.4.1	Anticipated negative impacts would be localized, affecting 84 acres or less (depending on size and location of spill); prompt cleanup would limit dispersal of contaminants, but resulting disturbance of surface vegetation would affect local permafrost.
Paleontology	4.4.4.2	No anticipated negative impacts.
Surface water resources	4.4.4.3	Negative impacts of guillotine break at a river crossing would be large, adversely affecting many miles of river and riverbank and requiring long-term cleanup; frequency (or likelihood) of such a spill in a river is very low, about 1 in 255 million.
Groundwater resources	4.4.4.4	Negative impacts of *likely* spills could be high if occurring in the Chugach Mountains; negative impacts of *unlikely* and *very unlikely* (i.e., larger volume) spills could also be high, with less locational restriction than for the *likely* spill.
Physical marine environment	4.4.4.5	Negative impacts could accompany a *very unlikely* spill at Valdez Marine Terminal, although release of a large amount of oil would in part be countered by confinement to an area about 2 mi from the terminal; impacts would be high, but relatively localized.
Air quality	4.4.4.6	Impacts would vary with the size of spill, horizontal dispersal, and time until cleanup; impacts appear under human health and safety.
Human health and safety	4.4.4.7	Negative impacts could accompany spill scenarios in all four probability categories, with smaller (more probable) spills requiring close proximity to receptors for high impacts; human health effects also could result from eating fish and marine invertebrates exposed to oil, although the level of exposure necessary to yield noteworthy human health impacts would be noticeable on the food affected (thereby likely leading to avoidance).
Biological resources	4.4.4.8 (Biological Resources, Overview), 4.4.4.9 (Terrestrial Vegetation and Wetlands), 4.4.4.10 (Fish), 4.4.4.11 (Birds and Terrestrial Mammals), and 4.4.4.12 (Threatened, Endangered, and Protected Species)	Negative impacts to vegetation would affect 84 acres or less and, although possibly long term, would involve a relatively very small land area. Negative impacts on fish could be severe and possibly long term for large spills under *unlikely* and *very unlikely* scenarios, depending on location and timing, although a large spill into a river is highly improbable. Negative impacts on terrestrial mammals and birds could be high (i.e., yield effects at a population level) if the spill was large or affected a concentration of animals (both highly improbable). Negative impacts of either terrestrial or waterborne spills on threatened, endangered, and protected species likely would be negligible to moderate, the latter resulting from a worst-case (low-probability) high-volume spill reaching Prince William Sound.

TABLE 4.4-39 (Cont.)

Issue Area	DEIS Section	Summary of Impacts[a]
Economics	4.4.4.13	Negative impacts on state revenues would potentially be large, a function of how long normal TAPS operations were interrupted by the spill; negative impacts on tourism and recreation probably would be small; negative impacts on property values would be limited to areas where alternative uses to the TAPS are possible (e.g., Fairbanks area); positive impacts might occur in the form of hiring additional staff for cleanup operations.
Subsistence	4.4.4.14	Large negative impacts on subsistence fisheries could occur locally from high-volume spills in rivers under certain conditions (shallow river, low flow, key period of fish reproduction), although the frequency (likelihood) of such an event in a river is very low (1 in 255 million); large negative impacts on terrestrial subsistence resources could occur locally if a large number of animals are concentrated and hence affected, although the frequency (likelihood) of this occurring is very remote.
Sociocultural systems	4.4.4.15	Negative impacts could occur due to large spills that undermine subsistence fisheries or terrestrial game, thereby disrupting local rural economies that rely largely on subsistence; positive impacts would occur in the form of employment opportunities for rural residents, both Alaska Native and non-Native.
Cultural resources	4.4.4.16	Negative impacts could accompany spills of sufficient volume to affect important cultural resources near the TAPS.
Land use and coastal zone management	4.4.4.17	Negative land use impacts would be possible, depending on the size, location, and timing of a spill, although impacts would be limited in geographic extent; negative impacts to coastal zone management also would be possible, depending on the size, location, and timing of a spill, with terrestrial impacts limited in geographic extent and water-borne spills potentially affecting a larger area, both having possible (though highly unlikely) subsistence impacts.
Recreation, wilderness, and aesthetics	4.4.4.18	Negative recreation impacts could be long-term and severe, depending on the location and extent of a spill, until cleanup is complete; negative impacts on Wilderness Area in Gates of the Arctic NPP would be possible only via a large-volume spill into the Koyukuk River, both of which are highly improbable; negative impacts could affect aesthetics, depending on the location, duration, and timing of the spill, with the greatest negative impacts associated with parks, wilderness areas, recreation areas, and localities visible from a public road.

[a] Impacts are summarized here for the convenience of the reader. Details of the impact evaluations could not be included because of space limitations; additional information for each issue area may be found in the referenced EIS section.

release (see Section 4.4.4.7). Regulatory limits provide protection in some cases, such as exposure to contaminated water and soil. In other cases, estimates of likely negative health impacts are not anticipated to be high enough to warrant concern — such as the ingestion of fish and marine invertebrates exposed to a spill. The exception to these tendencies is a large spill, with or without fire, where inhalation of contaminants could introduce unacceptably high human health impacts. The location of such a spill-fire event would be critical. The analysis in Section 4.4.4.7 indicates that human health impacts could accompany *anticipated* (i.e., small volume) spills within 0.02 km of receptors, *likely* spills within 0.4 km of receptors, and *unlikely* or *very unlikely* (i.e., large volume) spills within 4.0 km of receptors. Available data indicate that 12 communities lie within 4.0 km of the TAPS (none closer than 0.4 km, however) (Table 4.4-40). One of these 12 communities contains a disproportionately high percentage of minority residents, while 5 contain disproportionately high percentages of low-income residents, indicating the possibility of environmental justice impacts under certain *unlikely* and *very unlikely* spill scenarios. However, the likelihood of one of these improbable accidents occurring near any community, much less one with disproportionately high environmental justice populations, is extremely low. Rapid spill response, coupled with evacuation of any human population in danger of excessive exposure to fumes or smoke, would help to minimize possible impacts if such a spill did occur.

As discussed in Section 4.4.4.10, an oil spill in a river or stream crossed by the TAPS may cause high negative impacts to fish. The highest impacts would occur under a combination of particular circumstances — large volume spill, shallow stream or river, low-flow conditions, and a key period in anadromous or resident fish life cycle. Removing any of these circumstances would reduce the magnitude of the impact, whereas having them all occur at once in addition to the likelihood of a spill in a river would reduce the likelihood of occurrence considerably (although it would increase the impacts should it occur). The main environmental justice impacts of a spill affecting

TABLE 4.4-40 Communities Within 4.0 km of the TAPS Possibly Experiencing High Human Health Impacts due to *Unlikely* or *Very Unlikely* Spills[a]

Community	Disproportionately High Minority Population	Disproportionately High Low-Income Population
Big Delta		X
Coldfoot		
Copper Center	X	X
Copperville		X
Delta Junction		
Fox		
Livengood		
Moose Creek		
Tazlina		X
Tonsina		
Valdez		
Wiseman		X

[a] X = minority population in 2000 in excess of 32.4% or low-income population in excess of 9.6%.

Source: Summary of selected data from Table 3.29-1.

fish would be related largely to subsistence and sociocultural systems, both discussed below.

Under certain conditions, oil spills also could have high negative impacts (impacts at a population level) on birds and terrestrial mammals, as described in Section 4.4.4.11. Large-volume spills, under *unlikely* or *very unlikely* scenarios, affecting concentrations of birds or mammals are of particular concern. As noted in the original discussion of these impacts, large spills and concentrations of birds or terrestrial mammals are individually improbable, and the combination of these conditions is even less likely. The main environmental justice impacts of such a spill affecting birds or terrestrial mammals would largely concern subsistence and sociocultural systems, both discussed below.

Section 4.4.4.14 discusses impacts to subsistence from various spill scenarios. The most concerning negative impacts identified were those from *unlikely* and *very unlikely* large-volume spills in streams and rivers — that is, those just described for fish. As noted, under certain conditions the impact of a high-volume spill on fish would be large, taking the form primarily of high fish mortality. Under worst-case conditions, recovery of a subsistence fishery could take years. Although the amount of river or stream affected is anticipated to vary with spill volume, waterway configuration, and water flow, the larger areas affected would be sufficiently broad to preclude easy relocation of subsistence activities.

Consistent with federal guidelines in Alaska, this DEIS treats subsistence as an activity of rural Alaskans. Section 3.24 notes that 11 of the 45 communities considered in this study do not meet the rural requirements for subsistence. Many of the remaining communities (for which data are available) conduct subsistence fishing downstream from the TAPS (see Figure 3.24-1). The following could have their subsistence base affected by a large spill in the Gulkana River, given the estimated leading edge of an oil slick (see Table 4.4.4.3-5; see also Appendix D): Copper Center, Gakona, Glennallen, Gulkana, Kenny Lake, Paxson, and Tonsina. As noted in Section 4.4.4.10, because it is shallow, a large spill in the Gulkana River could be particularly harmful to fish. A large spill in the Tazlina River, in turn, could damage the subsistence fishery of Chitina, Copper Center, Gakona, Glennallen, Gulkana, Kenny Lake, and Tonsina. Several of these communities contained disproportionately high percentages of minority or low-income populations (Table 4.4-41). In combination with likely subsistence impacts this situation introduces the possibility of negative environmental justice impacts. Despite the impacts that would be likely given the specified conditions, as noted above the chance of large spills in a particular river would be quite improbable — on the order of 1 in 255 million for a guillotine break caused by a helicopter crash affecting a 300-ft length of pipeline crossing a specific waterway (see Section 4.4.4.3.1).

As discussed above, large spills under certain conditions also could have high impacts on birds and terrestrial mammals, both potential subsistence resources (depending on the location and species — see Section 3.24). However, as discussed in Section 4.4.4.14, subsistence impacts would not be extremely high from such a spill, primarily because terrestrial resources tend to be dispersed over broad geographic expanses and harvest areas typically involve large areas well removed from the TAPS (see Appendix D). Environmental justice impacts thus would not likely be a concern in terms of subsistence due to a spill with localized impacts on birds or terrestrial mammals.

As noted in the evaluation of impacts to sociocultural systems from spills (see Section 4.4.4.15), large spills in rivers or streams could disrupt subsistence in a way that also would affect sociocultural systems. For sociocultural systems with a heavy reliance on subsistence, such disruption could undermine a major portion of the economic or adaptive base of the society. As discussed above, the greatest impacts would occur through the combination of several conditions whose co-occurrence would be highly improbable. The area most likely to experience high and adverse subsistence impacts, and hence high and adverse socioeconomic impacts, would be that including the communities listed in Table 4.4-39 for spills in the Gulkana and Tazlina Rivers. The socioeconomic systems most likely affected

TABLE 4.4-41 Selected Communities Possibly Affected by Worst-Case *Very Unlikely* Guillotine Break during High-Flow Conditions, Gulkana and Copper Rivers

River/Community Affected	Disproportionately High Minority Population	Disproportionately High Low-Income Population
Gulkana River		
Copper Center	X[a]	X
Gakona		X
Glennallen		
Gulkana	X	X
Kenny Lake		X
Paxson		
Tonsina		
Tazlina/Copper Rivers		
Chitina	X	X
Copper Center	X	X
Gakona		X
Glennallen		
Gulkana	X	X
Kenny Lake		
Tonsina		

[a] X = minority population in 2000 in excess of 32.4% or low-income population in excess of 9.6%.

Source: Summary of selected data from Table 3.29-1.

adversely would be the Ahtna Athabascans and the general, rural non-Native socioeconomic system considered in several parts of this DEIS (see Section 3.25). As discussed above, high impacts on birds and terrestrial mammals are not anticipated to generate large subsistence impacts and, therefore, should not disrupt sociocultural systems to any great extent.

High and adverse impacts to recreation and aesthetics are anticipated under certain spill scenarios — for recreation areas or parks near the TAPS, and for Wild and Scenic Rivers that might be affected (see Section 4.4.4.18). Although several recreation areas and parks (or portions thereof) occur in the vicinity of the TAPS, only three lie within one-quarter mile of the pipeline and related facilities (see Table 3.27-1), reducing the likelihood of noteworthy spill impacts and hence environmental justice concerns. However, the Gulkana River is federally designated as a Wild River and intersects the TAPS. Although a large spill into a particular river or stream is highly unlikely, such an event would have high and adverse impacts. Communities downstream of the TAPS on the Gulkana and Tazlina/Copper Rivers include Copper Center, Gulkana, Kenny Lake, and Tazlina (see Figure 1-2). Each of these communities contained disproportionately high percentages of minority persons in 2000 or low-income persons in 1990 (see Table 3.29-1). Data on the use of the Gulkana River for recreational purposes by either minority or low-income populations do not exist, although either may use it for recreation. Aesthetic impacts, in turn, could occur for any of the five communities listed in Table 4.4-39. As a result, environmental justice impacts in recreation and aesthetics may accompany large spills into the Gulkana River.

The examination of environmental justice tends to focus on negative impacts, in a manner consistent with the definition of the concept in Executive Order 12898. However, short-term positive impacts likely would also accompany spills in the form of employment of local people on cleanup crews, providing wage employment to areas where jobs paying cash often are hard to find (see Section 4.4.4.15). If individuals living close to the spill are hired, the relatively large percentage of low-income and minority residents near the TAPS, coupled with agreements for employment between APSC and selected Alaska Native villages, suggests that environmental justice populations would be among the beneficiaries of spill-related employment.

In summary, it is important to reiterate that the high and adverse impacts discussed would be the result of generally highly improbable accidents, not normal operation of the TAPS. This statement is not meant to downplay the possible consequences of such accidents, which, in many cases, could be severe and last several years. Rather, it is meant to help us keep in perspective that the spills necessary to generate the impacts mentioned above probably would not occur during the renewal period. Should such an accident occur, explicit steps would be taken to limit impacts and mitigate consequences, for both environmental justice populations and affected people in general.

4.5 Less-Than-30-Year Renewal Alternative Analysis

4.5.1 Summary Description of the Less-Than-30-Year Renewal Alternative

4.5.1.1 Introduction

The alternative of renewing the Federal Grant for the TAPS ROW for less than 30 years evaluates the consequences of continuing TAPS operation for a shorter period than has been proposed. It provides a basis for assessing environmental impacts or issues that could be time dependent (i.e., that could have a greater or lesser effect if the renewal period was less than 30 years). This alternative is not functionally different from the proposed action alternative. Implementation (e.g., mitigating factors, laws, regulations, or oversight) by the federal government of a renewal period for less than 30 years would be no different than for the proposed action.

4.5.1.2 Spill Scenarios under the Less-Than-30-Year Renewal Alternative

The principal parameters that characterize spills are the frequency of occurrence and the quantity of crude oil or other substances released to the environment. This section discusses those parameters for postulated spills for the pipeline, the Valdez Marine Terminal, the North Slope, and tanker transport in Prince William Sound for the less-than-30-year renewal alternative. Although the length of the renewal period (which determines whether the pipeline is assumed to operate for another 30 years or for some shorter period) could affect both frequency of spills and quantity spilled, the analysis summarized in this section indicates that for the periods of time being considered, the duration of the renewal period would not significantly alter the results presented for the 30-year renewal alternative. Therefore, the scenarios discussed in Section 4.4.1 can also be used to characterize the spill events for a renewal period of less than 30 years.

4.5.1.2.1 Factors Affecting Frequency of Spills.

Pipeline. The frequency of spills along the pipeline can be affected by changes in throughput, the age of the pipeline, changes in climate, or other external factors such as changes in population along the pipeline and accessibility of the pipeline to more people. Age-related factors include corrosion of the pipeline, frequency of maintenance activities, and potential for metal fatigue.

Throughput: The current TAPS throughput (the volume of crude oil pumped through the pipeline) is about 1.1 million bbl/d. The highest capacity throughput at which the TAPS can operate is 2.1 million bbl/d. For the 30-year renewal period, it is estimated that throughput would decline gradually to about 0.75 million bbl/d in 2019 (15-year renewal) and about 0.3 million bbl/d in 2031 (DOE 2001a). If other factors remained unchanged, the annual frequency of spills would be expected to remain the same or be reduced as the throughput declined. For spills initiated by natural causes, such as earthquakes, the frequency would not be expected to change because of changes in throughput. However, for some events that are initiated by human activity, such as a truck or an airplane crashing into the pipeline, the frequency may be reduced when the throughput is reduced because there may be less occurrence of the activity (i.e., reduced TAPS-related truck and aircraft traffic near the pipeline because of the decline in support needed for the TAPS with declining throughput, although this decline may be offset by a potential increase in tourism in Alaska). However, such differences are expected to be small and are difficult to quantify. Therefore, for the purposes of analyses in this DEIS, it is assumed that the annual spill frequencies would remain the same as the throughput changes. The net effect of this assumption would be that the likelihood of occurrence of spills would be proportional to the length of the renewal period regardless of throughput level; for example, a spill would be twice as likely to occur over a 30-year renewal period as it would over a 15-year renewal period.

Age of the Pipeline: As the pipeline ages, it can be expected that both the physical conditions of the pipeline and the activities on the part of the owners to maintain the pipeline would change. One of the main physical changes is related to pipeline corrosion. The pipeline is known to have corroded in certain sections. For example, an 8.5-mi section of the pipeline was rerouted in the Atigun River valley region in 1991 because of excessive corrosion. Since then, the monitoring and surveillance activities have increased with the use of smart pigs, cathodic protection, and other techniques that both monitor and prevent corrosion along the pipeline (see Sections 4.1.2.3 and 4.1.3.2 for more detail). In addition, the recently initiated Reliability-Centered Maintenance (RCM) program is intended to prevent failure of the pipeline, including failure from corrosion. Because of the heightened awareness and increased monitoring and prevention programs in place, it is not expected that the annual frequency of spills resulting from pipeline corrosion would increase. In fact, it may be expected to decrease because of these precautions. However, for the purposes of analysis it is conservatively assumed that it would stay the same.

The increased surveillance and monitoring activities and potential increases in remediation activities that could result could themselves cause the annual frequency of spills to increase. On the other hand, if the maintenance and prevention programs (e.g., RCM and cathodic protection) were successful, there would be less need to conduct remediation activities, which would reduce the likelihood of spills. Therefore, the annual frequency of spills resulting from surveillance, monitoring, and maintenance activities along the pipeline could be either higher or lower at the end of 30 years compared with the renewal period of less than 30 years. These changes, however, are expected to be relatively small. The frequencies over any renewal period of 30 years or less are not expected to change enough to shift the frequency designations of the spill scenarios discussed in Section 4.4.1.

Another age-related phenomenon that could increase the frequency of spills along the pipeline is metal fatigue (cracking and/or breaking of metal parts because of repeated stresses, such as by flexing or bending). Certain sections of the pipeline are subjected to repeated forces that could cause metal fatigue. For example, a small section of the pipeline in the Thompson Pass region in the past vibrated under certain slack-line conditions (a condition in a downhill section of the pipeline where the oil does not completely fill the pipeline, and part of the pipeline is filled with hydrocarbon vapors). The back pressure in the pipeline downstream from Thompson Pass has been adjusted and the vibrations have stopped. This modification was implemented in 1997 through the installation of a back-pressure control system at the Valdez Marine Terminal (APSC 2000a). However, as the throughput in the pipeline decreases with time, as currently projected (see above), the number of places where slack-line conditions could occur and their frequency may increase.

Vibrations also occur in the piping near the mainline pumps. It is reported that potential slack-line areas, such as Thompson Pass, have been studied and either fatigue life has been determined to be unlimited or corrective actions have been implemented (APSC 2001n). It is also reported by APSC (2001n) that operators routinely check for fatigue damage to piping near the mainline pumps and implement corrective measures as required to maintain system reliability. Because of these actions, it is assumed that the frequency of spill events caused by metal fatigue will not change between the 30-year renewal and less-than-30-year renewal options. However, as stated above, the frequency of maintenance activities and the frequency of spills caused by maintenance activities may change slightly. Twenty-five years of performance data on Western European cross-country oil pipelines indicate no evidence to show that the aging of the pipeline system increases either the frequency or the volume of spills (CONCAWE 1998).

Climate Change: Changes in climate could affect the integrity of the pipeline; for example, by increases in frost jacking, subsidence, or landslides in areas of unstable permafrost, or by increases in flooding and washout in valleys and river crossings. As discussed in Section 3.12.7, there is some evidence to indicate that regional warming has occurred over the last several decades in Alaska. The estimated increase in surface air and permafrost temperatures varied from less than a degree to a few degrees Celsius. It is not clear if the same trend would continue over the ROW renewal period. If it did, it may be expected that the temperature would increase by a few degrees or less above current values. The direct impact of such warming on the pipeline is not readily quantifiable at this time. However, the pipeline is continuously being monitored. Any variations in temperature because of climate change and its effects on the pipeline would be gradual. If the trends indicated deterioration in the condition of the pipeline, necessary precautions would be taken to remedy the situation or the pipeline would be shut down.

Population Changes and Accessibility of the Pipeline: It is likely that the population in regions along the pipeline will increase and that the pipeline will be more accessible to people, particularly north of Fairbanks, in the future. It is also likely that these changes would be greater over a 30-year period than over a period of less than 30 years. The U.S. Bureau of the Census projects that Alaska's total population will increase from 653,000 in the year 2000 to 885,000 in year 2025, an increase of 35% in 25 years, or somewhat greater than the projected national increase of 23% for the same time period (U.S. Bureau of the Census 2002a). This population increase could increase or decrease the frequency of certain spill scenarios (e.g., the sabotage and vandalism scenario). However, such changes are difficult to quantify and are not expected to be sufficiently large to alter the frequency designations for the postulated pipeline accidents in Section 4.4.1.

Valdez Marine Terminal. As discussed above for the pipeline, changes in throughput over time can also affect the frequencies of certain spill scenarios at the Valdez Marine Terminal. Throughput would affect a certain number of unit operations at the Valdez Marine Terminal, including the loading of tankers. As a result, annual frequency of spills during tanker loading operations, such as the spill scenario entitled "Failure of Loading System between Dock and Ship" in Section 4.4.1, could decrease with decreasing throughput. Also, the number of employees at the Valdez Marine Terminal could decrease as the throughput decreased. This reduction in employees could cause the frequency of postulated spills resulting from aircraft crashes into tanks to be reduced at lower throughputs because less staff at the Valdez Marine Terminal could mean fewer flights in and out of Valdez Airport. Frequencies of spills in the anticipated and likely frequency categories, which were derived from operating experience at the Valdez Marine Terminal, can also be expected to be lower because of lower throughput . However, such changes would not have a significant effect on the frequencies, and the frequency designations for the scenarios described in Section 4.4.1.1 at the Valdez Marine Terminal would not change.

Prince William Sound. The spill frequencies in the Prince William Sound would be affected mainly by two anticipated future changes: (1) the decline in the pipeline throughput quantities, and (2) the move from a fleet currently made up of mostly single-hulled tankers to a fleet of all double-hulled tankers by 2014. Declining throughput would mean less tanker traffic and smaller frequency for all scenarios considered in Section 4.7.4.10. Double-hulled tankers are less prone to spills in the case of collisions or structural damage, and, therefore, their use results in a smaller frequency of spills for the same types of initiators compared with single-hulled tankers. Some of the decrease in frequency of spill events because of a smaller tanker fleet may be offset by other factors, such as a potential increase in tourism-related marine traffic in Prince William Sound. The frequencies and frequency category designations of spill scenarios described in Section 4.7.4.10 are based on analyses that take into account both of the factors mentioned above. The frequencies are given as "high," corresponding to current throughput and fleet, and "low," corresponding to projected throughput and fleet at the end of the renewal period. The renewal period assumed in Section 4.7.4.10 is 30 years. For any period less than 30 years, the low end of the frequency range would be higher than that given in Section 4.7.4.10 but still below that of the high end of the frequency range (i.e., current throughput and reliance primarily on single-hulled tankers).

North Slope. The main factor that may influence the frequency of spills in the North Slope is throughput as it relates to the number of wells and pipelines in operation at the North Slope. In general, the more oil being pumped from the ground, the more likely the occurrence of spills. However, the estimates provided in Section 4.7.4.10 are based on historical data or information from sources that did not take into account lower production potential at the North Slope. As a result, the frequency estimates given in Section 4.7.4.10 are conservative for future operations under either a 30-year renewal or a less-than-30-year renewal alternative.

4.5.1.2.2 Factors Affecting Volume of Spills.

Pipeline. The only time-dependent factor that could affect the volume of oil spilled from the pipeline is throughput. In most scenarios, the throughput plays little or no role in determining the spill volume. However, in scenarios involving a large break in the pipeline, such as a guillotine break, throughput becomes a factor.

The spill volume in a guillotine break accident is estimated on the basis of two considerations: (1) the dynamic volume — the quantity of oil that would be pumped through the section of the pipe where the break occurs from the time of the break until the pumps upstream are shut down and the mainline valves are closed, and (2) the static volume — the amount of oil spilled from the break because of hydraulic heads established at elevations higher than the break location. The first component is proportional to the throughput (i.e., the spill volume decreases with decreasing throughput), whereas the second component is independent of the throughput.

As the throughput decreases and because of economic and technical considerations, the TAPS Owners may shut down some of the mainline pump stations. For example, when the guillotine break scenario spill volumes were estimated for a 0.3 million bbl/d throughput under the proposed action alternative, it was assumed that the currently operating PS 7 and 12 would be shut down. It was also assumed, as required by JPO Stipulations, that appropriate mainline valves would be installed in place of the removed pump stations so that the static spill volumes would remain about the same. As discussed below, the net effect was that the maximum spill volume was estimated to be less for a 0.3 million bbl/d throughput than for either a 1.1 million or 2.1 million bbl/d throughput. Removal of a pump station would alter the internal pressure in the pipeline in certain sections. The pressure could be higher or lower, depending on the location; however, it would always be within the allowable design limits of the pipeline. As a result, the changes in the estimated spill volumes for any of the spill scenarios would be relatively small.

For the proposed action alternative, three throughputs were considered: 2.1 million bbl/d (maximum TAPS design value with the use of drag reducing agent), 1.1 million bbl/d (current value), and 0.3 million bbl/d (estimated minimum throughput for the TAPS under the current operating conditions, which is also the projected North Slope production value in DOE [2001a] for the year 2031). The maximum estimated release was about 54,000 bbl for the 2.1 million bbl/d and 1.1 million bbl/d throughputs. When the throughput was reduced to 0.3 million bbl/d, the maximum estimated spill volume was about 52,000 bbl. If the grant renewal was for a period less than 30 years, according to the DOE projections (DOE 2001a), the pipeline throughput is likely to be between 1.1 million and 0.3 million bbl/d. For example, the projected throughput in 2019 (15-year renewal) is about 0.75 million bbl/d. For reasons mentioned above, the estimated maximum spill volume for a guillotine break scenario would be between about 54,000 bbl and 52,000 bbl for throughputs between 1.1 million bbl/d and 0.3 million bbl/d, respectively.

As the throughput decreases over time, there is greater likelihood of slack-line conditions developing along the pipeline. Leak detection in slack areas is more difficult, and minimum detection levels are generally higher. Therefore, if there is a relatively small, not easily detectable, leak in the pipe, the quantity of oil released would probably be greater in a slack area than in other parts of the pipeline. This situation would mean that the volume of oil spilled could be larger for longer renewal periods during scenarios that involve small holes in the pipeline.

Valdez Marine Terminal. The spill volume estimates given in Section 4.4.1 for scenarios considered at the Valdez Marine Terminal would be the same irrespective of the renewal period, unless lower throughputs result in closure of portions of the Valdez Marine Terminal. For example, it may be possible that crude oil storage at the Valdez Marine Terminal would only occur at the West Tank Farm at low throughputs. However, such changes are difficult to quantify and are not expected to be sufficiently large to alter the spill volume estimates at the Valdez Marine Terminal at low throughputs.

Prince William Sound. The quantity of oil spilled from a double-hulled tanker is estimated to be less than the volume spilled from a single-hulled tanker for a given severity accident (National Research Council 2001). After 2014, all tankers carrying crude oil from the Valdez Marine Terminal are expected to be double hulled. As a result, one would expect that the spill volumes from the postulated accidents in Prince William Sound would decrease after 2014, when the complete tanker fleet is scheduled to be double hulled. In estimating the spill volumes given in Table 4.7-6 (Section 4.7.4.10.4) for the cumulative impacts analysis, that distinction was not made, and it was conservatively assumed that the spill volumes from double-hulled tankers would be similar to those from single-hulled tankers.

North Slope. The spill volume estimates given in Table 4.7-4 (Section 4.7.4.10.3) for scenarios considered at the North Slope would be the same irrespective of the pipeline ROW renewal period.

4.5.1.2.3 Summary and Conclusions. The renewal period could cause slight modifications to the estimated frequencies and spill volumes for the postulated spill scenarios along the pipeline, at the Valdez Marine Terminal, at the North Slope, and during tanker transport through the Prince William Sound. Table 4.5-1 summarizes these changes and indicates the relative importance of such changes compared with the values for the 30-year renewal period. Because of the uncertainties and the conservative nature of assumptions made in estimating the spill parameters under the proposed action alternative, the same estimates can be used to describe the spill events that could occur under a less-than-30-year renewal alternative without significantly affecting the estimates of the impacts of the TAPS on the human and natural environment.

4.5.2 Impact Analysis of the Less-Than-30-Year Renewal Alternative

4.5.2.1 Physiography and Geology

Several impacting factors involved with the operation of the TAPS are time dependent, including the removal of geologic resources and the influence of a regional warming trend in Alaska on mass-wasting geologic processes. The removal of sand, gravel, and quarry stones would continue with the operation of the TAPS. Similarly, mass-wasting processes would increase with the general warming trend in Alaska, potentially impacting the integrity of the TAPS. However, because the impacts evaluated for the 30-year renewal period would be either insignificant or mitigated (see Section 4.3.1), impacts associated with a shorter renewal period would be correspondingly smaller.

TABLE 4.5-1 Summary of the Effects of the Renewal Period on Spill Scenarios

	Frequency		Spill Volume	
Location	Potential Effect	Relative Importance[a]	Potential Effect	Relative Importance
Pipeline	The annual frequency of occurrence could increase with time for some scenarios but decrease for others.	Low. The changes are expected to be small, and the frequency range designations for the scenarios are not expected to change. (See Section 4.4.1 for definitions of frequency categories.)	For guillotine break scenarios, the spill volume is expected to be reduced with declining throughput over time. If slack-line conditions develop in some parts of the pipeline because of declining throughput and if a small leak occurs in those areas, the spill volume could be higher.	Low
Valdez Marine Terminal	The frequencies of some scenarios could be slightly less for longer times because of expected reductions in throughput.	Low	No change	Low
Prince William Sound	The frequencies of occurrence are expected to decline with time because of expected decline in throughput and changes in the composition of the tanker fleet.	Low to moderate. Declining throughput and the replacement of all single-hulled tankers with double-hulled tankers after 2014 is expected to reduce the frequency of spills.	The spill volume is expected to be lower for double-hulled tankers than for single-hulled tankers.	Moderate
North Slope	Reductions in production and closing of oil fields would be expected to reduce the frequency of spills over time.	Low	No change	None

[a] Relative to estimates provided in Sections 4.4.1 and 4.7.4.10 under the proposed action.

4.5.2.2 Soils and Permafrost

The impacts on soils and permafrost from TAPS operations are closely related to excavation and the use of heavy equipment. These activities are regularly involved in maintenance tasks in pipeline rerouting, corrosion digs, valve replacements, and repairs of buried pipe. Because the number of maintenance jobs would increase with time, the impacts on soils and permafrost are time dependent. In addition, with the general warming trend in Alaska, the degradation of permafrost along the TAPS would also potentially increase with time. Therefore, the magnitudes of the impacts associated with a shorter renewal period would be less than those for the proposed 30-year renewal period (see Section 4.3.2), and those impacts that did occur would be small and local.

4.5.2.3 Seismicity

The time-dependent impacting factor that is related to seismicity results from the combined effects of earthquakes and the degradation of permafrost along the TAPS with time. With potential progressive degradation of permafrost, the area potentially susceptible to earthquake-triggered landslides and liquefaction increases. As a result, the risk associated with a shorter renewal period would be smaller than the risk for the full renewal period (see Section 4.3.3). However, the impacts of spills caused by earthquake-triggered landslides and liquefaction events would be the same whether the renewal period was 30 years or less.

4.5.2.4 Sand, Gravel, and Quarry Resources

The quantities of sand, gravel, and quarry stone used for TAPS maintenance activities are time dependent. Because less of these materials would be needed for a shorter renewal period, the total magnitude of impacts associated with the extraction of these materials (see Section 4.3.4) would be less with a shorter renewal period than with the full 30-year renewal period. The impacts that would occur would be small and local.

4.5.2.5 Paleontology

Impacts associated with the less-than-30-year renewal alternative would be the same as those described under the proposed action (see Section 4.3.5). No adverse effects on known paleontological resources are expected regardless of the length of the renewal period.

4.5.2.6 Surface Water Resources

Several impacting factors that could affect surface water resources are time dependent. These factors include use of water for continued operations and maintenance activities, disposal of wastes from continued operations (e.g., land spreading of wastewater) and planned maintenance, and the continued presence of river structures at elevated pipeline crossings. All of these impacting factors would have effects that increase with time. Because the impacts evaluated for the full renewal period would be small and local (see Section 4.3.6), impacts associated with a shorter renewal period would be accordingly smaller.

4.5.2.7 Groundwater Resources

Impacting factors that can affect groundwater resources include the continued use of groundwater wells to supply water for continued operations and planned maintenance activities and disposal of wastes from continued operations (e.g., land spreading of wastewater and the use of septic systems) and planned maintenance. All of these impacting factors would have effects that potentially increase with time. Because the impacts evaluated for the full renewal period would be small and local (see Section 4.3.7), impacts associated with a shorter renewal period would be accordingly smaller.

4.5.2.8 Physical Marine Environment

Several impacting factors that could affect physical marine resources are time dependent. These factors include continued operation of the BWTF and other activities at the Valdez Marine Terminal. The effects of these impacting factors would increase with time. Because the impacts evaluated for the full renewal period (30 years) are judged to be negligible to small and local (see Section 4.3.8) impacts associated with a shorter renewal period would be accordingly smaller.

Tanker traffic associated with the TAPS is also time dependent. The current fleet serving the Valdez Marine Terminal consists of 26 tankers (National Research Council 1991), including 3 with double hulls, 13 with double sides, and 10 with single hulls and single sides. The number of tankers is expected to decrease substantially from the present 26 tankers to 8 to 10 tankers by the year 2020 (TAPS Owners 2001a). Tanker transits are also expected to decrease (TAPS Owners 2001a). According to this schedule, the last of the present tankers will be phased out by the end of the year 2013, and the fleet will consist exclusively of double-hulled tankers beginning in 2014. Double-hulled tankers offer environmental advantages in terms of a reduced likelihood and volume of potential oil spills (National Research Council 1991, 1998).

A smaller tanker fleet would require fewer berths at the Valdez Marine Terminal. There are four berths at present; one is a floating berth, and three are fixed-platform berths. One or two of these berths might be shut down in the future. The two berths with tanker vapor control facilities would remain in operation (TAPS Owners 2001a).

4.5.2.9 Air Quality

This section describes estimated potential impacts of air quality and AQRVs for the less-than-30-year renewal alternative with respect to ambient air quality (criteria and hazardous air pollutants), visibility, acid deposition, and accumulation of CO_2 in the atmosphere.

Air pollutants, once emitted from a source, travel downwind as they are dispersed horizontally and vertically by air turbulence. While they are being transported and dispersed, the pollutants are converted to different species by chemical reactions in the atmosphere, and eventually they are removed from the atmosphere by dry and wet deposition onto the earth's surface. Therefore, potential impacts of air pollutants emitted by TAPS-related activities on ambient air quality and visibility at downwind receptors would be of a transient nature and would cease a short time after the pollutants were emitted from the source (less than a few days to tens of days for criteria and hazardous air pollutants). The difference in potential impacts on ambient air quality and visibility between the proposed action (30-year renewal period) and the less-than-30-year renewal alternative would be in the duration of impacts, that is, 30 years versus less than 30 years. The level of potential impacts on ambient air quality and visibility would be the same while those impacts were occurring.

Acidic species are formed in the atmosphere by chemical conversion of precursors, such as SO_2 and NO_x. Potential impacts of acid deposition on sensitive lakes could accumulate over time, depending on the acid-neutralizing capacity of the water body. Acidic deposition rates in Alaska are very low (see Section 3.13.2.4), and the TAPS-related precursor emission rates are relatively small in comparison with the overall precursor emissions in Alaska (see Table 3.13-4). Therefore, potential accumulation of impacts on sensitive receptors in Alaska from acidic deposition resulting from TAPS-related emissions is estimated to be minor regardless of the duration of future operation of the TAPS.

Potential impacts of CO_2 emissions from TAPS-related activities on the global CO_2 concentration level would be cumulative because of CO_2's long residence time[1] in the atmosphere (about 15 years). Therefore, the difference in potential impacts on the global CO_2 concentration level between the proposed action (30-year license renewal period) and less-than-30-year renewal alternative would be in (1) the duration of CO_2 addition to the atmosphere, (i.e., 30 years versus less than 30 years), and (2) cumulative impacts, which would be higher and persist longer under the proposed action than under a less-than-30-year renewal

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1 Residence time of an air pollutant species is the length of time that the pollutant remains in the atmosphere in its original form.

alternative. However, potential impacts due to accumulation of TAPS-related CO_2 emissions on the global CO_2 concentration level are estimated to be minor regardless of the duration of future operation of TAPS, because the TAPS-related CO_2 emission rate is very small in comparison with the global CO_2 emission rate (see Section 3.13.1.3).

4.5.2.10 Noise

Noise is quickly dissipated in the atmosphere, and the noise at a receptor location in the vicinity of a noise source exists only for the time it is emitted. Therefore, impacts of TAPS-related noise would not accumulate and would cease to exist almost immediately after the termination of the noise-generating activities. The difference in potential noise impacts between the proposed action (30-year renewal period) and a less-than-30-year renewal alternative would be in the duration of noise emissions from TAPS facilities (i.e., 30 years versus less than 30 years).

4.5.2.11 Transportation

Transportation impacts from a less-than-30-year renewal period would be the same as those discussed for the proposed action in Section 4.3.11. TAPS operations would continue, and the transportation network would be capable of supporting pipeline activities at any anticipated pipeline throughput level.

4.5.2.12 Hazardous Materials and Waste Management

Relative to the types of hazardous material used or wastes generated, very few differences would be expected between the less-than-30-year renewal alternative and the 30-year renewal. The major sources of the wastes generated from TAPS operations include maintenance, repairs, and responses to accidental releases of crude oil or hazardous materials. Other major wastes include solid wastes and domestic and sanitary wastewaters associated with support of the workforce that resides at TAPS facilities. Waste-generating activities are expected to remain generally the same under the less-than-30-year renewal alternative. Further, except for technological advancements, the techniques used to accomplish maintenance and repairs can be expected to remain the same, and, thus, hazardous materials supporting such activities would also be unchanged. However, opportunities would still exist to reduce hazardous material usage (and hazardous waste generation) through pollution prevention initiatives.

While the character of the wastes that would be generated is expected to be the same as that for the proposed action, shorter periods of operation would affect the amounts of wastes produced. The majority of waste produced is related to pipeline and infrastructure maintenance. Such maintenance activities occur on a cyclical basis. Assuming these maintenance "cycles" are not otherwise affected by RCM protocols under development, the number of maintenance cycles may be less for operational periods of less than 30 years, and, thus, the total amount of maintenance-related waste would be reduced. In addition to wastes resulting from scheduled maintenance, some waste may result from repair actions dictated by results of ongoing TAPS monitoring or surveillance activities. For example, data collected from instrument pig runs may dictate closer inspection and possibly repairs or replacement of pipeline corrosion control coatings, resulting in the generation of associated wastes. The frequency of occurrence of such "as-needed" or "as-directed" repair actions is not predictable, although it is intuitive that shorter periods of TAPS operation would reduce the probability of repair actions being required and thus reduce the volumes of associated wastes.

As discussed in Section 4.5.1.2, annual spill frequencies would be approximately the same under the 30-year and less-than-30-year alternatives. Therefore, the annual qualities of wastes generated as a result of spills would be the same for either alternative. However, the total quantity of spill-related waste generated over the renewal period would be expected to be proportionally higher under the 30-year alternative than the less-than-30-year alternative. In addition, on the basis of throughput projections, the volume of oil potentially at risk for release from any point in the pipeline would decrease over time.

Frequencies of tanker spills and volumes of crude oil released can also be expected to decrease between now and January 2015 and continue at that lower level because of the reconfiguration of the tanker fleet to intrinsically safer double-hulled design. Volumes of remediation wastes resulting from any release would depend on many circumstantial factors. Thus, while the decreasing frequencies of some spill events may be predicable, changes to the volumes of remediation wastes are not.

Finally, Section 4.3.12 discusses the potential impacts to hazardous material usage and waste generation that would result from the completion of the planned pump station and Valdez Marine Terminal upgrades. While the precise schedule for initiating and completing those upgrades has not been set, the net result is expected to be a general decrease in the amounts of maintenance-related wastes (for both TAPS equipment and infrastructure), as well as a decrease in wastes associated with workforce support. Those reductions would be realized upon completion of the upgrades and continuously thereafter. Decreases in volumes of maintenance-related wastes would be realized only if TAPS upgrades were completed before the expiration of any less-than-30-year operating period.

4.5.2.13 Human Health and Safety

4.5.2.13.1 Occupational. Section 4.3.13.1 discussed potential impacts to health and safety for workers from routine operation of the TAPS for a 30-year period. Specifically, the industrial risks of injuries and fatalities from physical hazards to operations and maintenance workers were evaluated. The expected annual number of worker fatalities and injuries for specific industry types was calculated on the basis of BLS and NSC rate data and on the estimated number of annual full-time equivalent workers required for operations and maintenance activities along the pipeline. Under the less-than-30-year alternative, the annual incidence of fatalities and injuries for operation of the TAPS remains the same for a given year. However, the total number of fatalities and injuries for a period of time less than 30 years would be less, that is, roughly proportional to the reduction in the number of years.

4.5.2.13.2 Public. Section 4.3.13.2 discussed potential impacts to health and safety for the general public from routine operation of the TAPS for a 30-year period. Specifically, potential impacts from BWTF effluents to Port Valdez and from air emissions from the Valdez Marine Terminal were evaluated. These impacts were considered to be bounding impacts for emissions from normal operations along the entire ROW (see Section 4.3.13.2 for supporting rationale).

With respect to human health risk associated with water effluents from the BWTF to Port Valdez, risks from fish and shellfish consumption are directly related to length of exposure. However, contaminants may be persistent in sediments; thus, exposures may not end when TAPS operations end. Overall, it is expected that the less-than-30 year alternative would not substantially change the risk estimated for the BWTF in Section 4.3.13.2.1 (i.e., fish and shellfish consumption risk not exceeding 1×10^{-5}).

Air emissions from the Valdez Marine Terminal would be expected to decrease if throughput decreased. Also, inhalation cancer risk is related to the total length of exposure, so that decreasing the length of operations would decrease risk. As detailed in Section 4.3.13.2, the increased cancer risk in residential areas from Valdez Marine Terminal emissions would be below guideline levels under the proposed 30-year renewal. Risks would be somewhat lower still for the less-than-30-year alternative.

Section 4.5.1.2 provides an in-depth discussion of how spill scenarios might change under the less-than-30-year alternative. It is concluded that the number of spills would be roughly proportional to the length of the renewal period. For example, spills would be twice as likely to occur over a 30-year renewal period as over a 15-year renewal period. With respect to spill volumes, these are partially dependent on throughput, which would likely remain higher in the near term (staying at about 1 million bbl/d out to about the year 2020) and then decrease to about 0.3 million bbl/d by 2031 if a 30-year renewal is granted. Similar maximum spill volumes are predicted for guillotine breaks along the pipeline for both of these throughput rates. The conservative nature of the human health impact estimates from spills for the proposed 30-year renewal (see Section 4.4.4.7) would make those estimates also applicable for the less-than-30-year renewal alternative.

4.5.2.14 Biological Resources Overview

Impacts of the less-than-30-year renewal alternative on biological resources would be similar to those of the proposed action because operations, monitoring, and maintenance activities are, for the most part, independent of the length of the renewal period. The actual impact of this alternative would depend on the length of the renewal period and the ultimate disposition of TAPS and the ROW (i.e., the nature of termination activities).

If, at the end of the less-than-30-year renewal period, a decision were made to terminate TAPS, the impacts of this alternative on biological resources would be less than those of the proposed action. However, it is important to note that the impacts on biological resources from routine operations under the proposed action are expected to be within the range of impacts that have been experienced over the past 25 years of operations and that documented impacts to resources have been localized and are not considered significant. Consequently, any reduction in impacts resulting from a shorter renewal period would be small.

The probability of large spills would decrease with a shorter renewal period. However, under the proposed action, the probability of such a spill occurring is low, and this difference in probability does not provide a meaningful discriminator between the two alternatives.

4.5.2.15 Terrestrial Vegetation and Wetlands

This section evaluates the direct and indirect impacts of the less-than-30-year renewal alternative on vegetation and wetlands. Terrestrial and wetland vegetation communities and their component species may be affected by factors associated with the existence of TAPS facilities, normal operations, monitoring, and maintenance. Impacts to vegetation under this alternative would be similar to those under the proposed action (see Section 4.3.15); however, the impacts evaluated under this alternative would occur for a shorter period of time because of the reduced renewal period. In general, impacts to vegetation during the shorter time period evaluated under this alternative would be the same as those for that same portion of the 30-year renewal period.

Impacts associated with the existence of TAPS facilities would occur under the less-than-30-year renewal alternative. While the initial loss and alteration of vegetation communities would persist throughout the renewal period, vegetation established under past revegetation efforts within the ROW and other disturbed areas would continue to increase in cover and diversity of species. However, by the end of the less-than-30-year renewal period, the distribution and abundance of native species in these areas, the establishment of vegetation on poorly vegetated sites, and the development of natural communities would generally not reach the levels expected by the end of the 30-year renewal period.

Sedimentation impacts caused by erosion of the ROW may also occur under the less-than-30-year renewal alternative and may result in the degradation of wetland and terrestrial plant communities downgradient of the ROW. However, these events are expected to be very infrequent, and fewer such events would likely occur under a less-than-30-year renewal period than under the proposed action. The development of temporary impoundments because of the blockage of surface water crossings of the ROW, and subsequent impacts to terrestrial and wetland vegetation communities, would also be expected to be fewer under this alternative than under the proposed action. However, the frequency of occurrence of erosion and blockage events would be similar to that under the proposed action.

Impacts associated with the normal operation, monitoring, and maintenance of TAPS facilities would occur under the less-than-30-year renewal alternative. Normal operations and monitoring activities would be similar to those of the past and would not differ from those of the proposed action. Therefore, as under the proposed action, these activities would result in negligible additional impacts to vegetation.

Deposition of airborne dust generated by vehicle traffic along the Dalton Highway would be expected to occur at levels similar to current levels and those anticipated for the proposed action. Adverse impacts to vegetation would be expected to continue in reduced vegetation growth and altered species composition of affected communities. Communities along the Dalton Highway would thus remain in a disturbed condition.

Ground-disturbing activities related to routine maintenance, such as excavation and grading within the ROW, would be similar to those under the proposed action. These activities would include the removal of vegetation, primarily within the ROW, and subsequent restoration efforts. As under the proposed action, wetland areas within the ROW may be filled and wetlands may be temporarily drained or subject to sedimentation, and maintenance of slopes outside the ROW may result in the disturbance of previously undisturbed vegetation. Excavations for corrosion repairs are expected to increase over time, from about 15 per year at the start of the renewal period to possibly about 20 per year under the proposed action. Therefore, under a less-than-30-year renewal period, the average number of excavations per year may be fewer than under the proposed action. Impacts to vegetation from maintenance and repair of the buried gas line would be similar to those under the proposed action; annual levels of disturbance are expected to remain steady (several hundred feet per year).

Activities related to the vegetation management program and revegetation program would continue to be a part of routine maintenance. As under the proposed action, the control or brushing of woody species would maintain plant communities in portions of the ROW in early successional stages, although native shrubs would continue to increase in tundra areas.

Preventive maintenance and remedial measures would be expected to occur under the less-than-30-year renewal alternative at levels similar to the proposed action. These activities would include the placement of riprap in stream channels or along banks; construction of guidebanks, revetments, and new spurs; or stream channel stabilization. These may result in adverse impacts to terrestrial and wetland vegetation communities; however, impacts would be similar to those expected under the proposed action.

The expansion of material sites or development of new material sites would be expected under this alternative; however, the total demand for materials would likely be lower than that under the proposed action. The resulting impacts to terrestrial and wetland vegetation may include the removal of previously undisturbed communities within the sites, or alteration of adjacent or downstream communities from changes in drainage patterns or sedimentation.

4.5.2.16 Fish

Most of the potential impacts to fish from routine use of the TAPS (Section 4.3.16) are continuous impacts that would be ongoing during any period that the TAPS was in operation. As a consequence, it is anticipated that the impacts during a renewal period shorter than 30 years would not differ substantially from those described for the 30-year renewal period in Section 4.3.16.

Habitat alteration impacts caused by maintenance activities, erosion, and thermal irregularities at pipeline crossings and in floodplain areas (Section 4.3.16.1) would be expected to continue during any period of TAPS operation and would not be expected to have significant effects on fish populations as long as monitoring and regulatory mechanisms remain in place. Similarly, blockage of fish at stream crossings because of vehicular traffic, deterioration or improper maintenance of culverts and low-water crossings, or water withdrawals is not expected to be affected by a shorter renewal period for the ROW.

Impacts to fish from increased human access are a function not only of providing access points (e.g., maintenance roads and stream crossings) from which fish populations can be exploited, but also are a function of the size of the human population and societal pressures for people to utilize fish resources. Although the number and locations of access points to fish populations would not differ greatly over the course of the proposed 30-year renewal period or over a shorter renewal period, it is possible that the size of the human population and the pressures for people to utilize fish resources could differ in a nonlinear fashion over time. In the past, maintenance of fish of desired sizes and at desired population levels has been largely accomplished through regulations established by the Alaska Board of Fish and enforced by the ADF&G. As a consequence, it is anticipated that for a shorter renewal period, the impacts of increased human access to fish populations would be minor and would not differ substantially from those anticipated for the proposed action.

Spills resulting from human error are not considered to be time-dependent and, therefore, under a shorter renewal period would be expected to have impacts similar to those analyzed for a 30-year renewal period (Section 4.2.5). However, as discussed in Section 4.2.5, there would be a slightly reduced probability of occurrence for some spill scenarios, especially the larger spills, if the renewal period was for less than 30 years. This conclusion is based on the facts that some of the factors involved in equipment failure are time-dependent and the throughput of oil for the TAPS is projected to change over time. As a consequence, there would be a slightly decreased probability of a major oil spill (e.g., those scenarios described as unlikely or very unlikely to occur in Section 4.4.1) if the renewal period was shorter. If a large spill of crude oil was released into a freshwater environment or into Prince William Sound, the impacts (as described in Section 4.4.4.10) would be the same regardless of the length of the renewal period.

4.5.2.17 Birds and Terrestrial Mammals

Impacts to birds and terrestrial mammals from normal operation, monitoring, and maintenance of TAPS under a less-than-30-year renewal alternative would be similar to those for the proposed 30-year renewal period (Section 4.3.17).

The number of excavations per year for corrosion repairs would be less in the short term (i.e., about 15 per year), but could increase to 20 per year by the year 2034 (TAPS Owners 2001a). Therefore, under the less-than-30-year renewal alternative, the average number of yearly excavations for corrosion control would be less than for the proposed action. Assuming that the size of corrosion digs averages 50 by 200 ft, the extra five digs per year would only temporarily disturb a little more than 1.1 acres of habitat.

Similarly, yearly excavations for cathodic protection might increase in the later portion of the proposed 30-year renewal. However, less than 5 mi of pipeline is expected to require repair to cathodic protection systems over the 30-year period (TAPS Owners 2001a). In most cases, these repairs would involve excavations similar to those performed for corrosion repairs. The difference in temporary habitat loss per year for the less-than-30-year renewal alternative compared with the proposed 30-year renewal would be negligible (e.g., yearly differences would likely be within the same order of magnitude).

The presence of workers would also cause localized, short-term disturbance and displacement of wildlife from the work sites. However, the yearly difference between the two alternatives would be considered negligible (e.g., differences would likely be within the same order of magnitude) because of the limited area and relatively short amount of time required for each maintenance activity.

The potential for oil spills to occur over the less-than-30-year renewal period would be proportionately less than for the proposed 30-year renewal period because of the shorter period of pipeline operation. On the basis of information presented in Section 4.5.1.2, the spill volume for a guillotine break would decrease as throughput decreases, while the volume of a spill for a small, not easily detected leak could be higher if it occurred in a slack-line area. However, the relative importance of these differences between the alternatives would be low (Table 4.5-1). Therefore, potential impacts from an oil spill to birds and terrestrial mammals for the less-than-30-year renewal alternative would be considered the same as those presented for the proposed action (Section 4.4.4.11).

4.5.2.18 Threatened, Endangered, and Protected Species

The characteristics and magnitudes of impacts of the less-than-30-year alternative on threatened, endangered, and protected species would be similar to those of the proposed action (see Section 4.3.18). This similarity results from the nature of TAPS operations, monitoring, and maintenance activities, which are for the most part independent of the length of the renewal period. TAPS operations, maintenance, and monitoring activities and their associated impacts are ongoing and, aside from spills, occur at a relatively constant rate.

If, at the end of the less-than-30-year renewal period, a decision was made to terminate TAPS, the impacts of this alternative on threatened and endangered species would be less than the proposed action. However, it is important to note that the impacts of routine operations under the proposed action on threatened, endangered, and protected species are expected to be within the range of those experienced over the past 25 years of TAPS operations, and those operations are not known to have affected populations of listed and protected species in the project area. Consequently, any reduction in impact resulting from a shorter renewal period would be very small. The probability of a large spill also would decrease with a shorter renewal period. The probability of such a spill occurring is already very small under the proposed action, and this difference in probability does not provide a meaningful discriminator between the two alternatives.

4.5.2.19 Economics

The economic impacts of renewing the Federal Grant for less than 30 years would differ from those expected to occur during the corresponding years of a 30-year renewal (see Section 4.3.19). The difference would result from the impact that a less-than-30-year renewal period would have on oil company investment decisions for new North Slope production. Because of the high cost of oil field exploration and development, a fairly long production period is required to recover the substantial initial cost of North Slope petroleum projects. With a renewal period shorter than 30 years, investment in new North Slope production and the TAPS throughput level would be reduced as a result of the riskier business environment in which oil companies would be operating (Goldsmith 2002).

Private investment programs at the local and state levels are often only possible with modest and predictable growth in economic activity over a fairly long period. In the absence of these conditions, many private investment programs would be less likely to be funded, thus, affecting many areas of the local and state economy. Long-term, fairly predictable economic growth in Alaska has produced some degree of economic diversification in the state, resulting in less dependence on oil and gas as the primary source of growth and development. While industries such as seafood, tourism, and air cargo would continue to provide alternative sources of growth, a shorter renewal period would likely reduce the prospect of further diversification by creating a riskier business investment climate. This condition would result in less predictable employment prospects, slower income growth, and slower growth in population.

Public-sector investment and expenditure programs also rely on stable and predictable growth in tax revenues over a fairly long period.

To be cost effective, many state and local programs requiring a considerable commitment of funds in the initial stages of development require a fairly long operating period. A shorter renewal period would reduce the flow of funds into state and local governments, thereby reducing their ability to implement a wide range of programs requiring longer operating lives. This situation would especially be the case in the pipeline corridor region, where public expenditures and investment programs are closely related to the size and duration of oil-related tax revenues.

Compared with the 30-year renewal period, renewal for less than 30 years would have adverse impacts on the local, state, and national economies. However, because the length of a shorter renewal period has not been specified, the difference between the impacts of the 30-year renewal and shorter renewal period cannot be determined. The magnitudes of the impacts of the shorter renewal period would be between those of renewal for 30 years and those of nonrenewal. Compared with the 30-year renewal, at the state and local level a shorter renewal period would reduce growth rates in population, gross state product, employment, and income and would reduce tax revenues from North Slope production, likely increasing annual state budget deficits. At the national level, lost oil production resulting from a shorter renewal period would adversely affect domestic oil production, national energy security, balance of trade, and overall economic activity.

4.5.2.20 Subsistence

The assessment presented in Section 4.3.20 for impacts to subsistence under the proposed action concluded that any negative impacts on subsistence would likely be very small. However, this conclusion was somewhat tentative, primarily because of two key limitations of the available data: (1) the inability to associate effects on subsistence with the TAPS, as opposed to other activities or conditions that also would likely affect subsistence; and (2) the inability to evaluate the net effects of anticipated impacts on subsistence, to determine if possible benefits from the TAPS would outweigh the adverse impacts (or vice versa). The evaluation of impacts for a renewal of less than 30 years leads to a similar conclusion that any negative impacts on subsistence for a shorter renewal period would be very small, in all probability smaller than those under the proposed action. This conclusion also is tentative because of the same data inadequacies that hampered the proposed action evaluation.

The evaluation of the less-than-30-year renewal alternative considered the same potential effects as were considered under the proposed action (Section 4.3.20). As described in that discussion, despite uncertainty surrounding the degree of association of these effects with the TAPS and the ultimate net positive or negative contribution, their consequences likely would be quite small. The conclusions drawn for the proposed action rest on two considerations concerning impacts of the TAPS that also are pertinent here for a shorter renewal period:

- Limited access to (very small) parts of certain traditional subsistence harvest areas; and
- The continued use of the Dalton Highway to maintain TAPS operations along with the continued use of various access roads and airspace over the TAPS, and continued human activity around the TAPS – possibly disrupting the movement of small numbers of terrestrial mammals.

If the Federal Grant for the TAPS ROW was renewed for less than 30 years, both of these potential impacts likely would be less than was anticipated for the proposed action.

4.5.2.21 Sociocultural Systems

As discussed in Section 4.3.21, impacts to Alaska Native and rural non-Native sociocultural systems anticipated under the proposed action in a sense are expected to accumulate over time with continued modernization in Alaska. The oil industry has been central to this modernization over the past three decades, and because of the importance of the TAPS to Alaskan oil production, modernization ultimately is linked inextricably to the pipeline system. Renewing the Federal Grant for less than 30 years would likely yield sociocultural impacts less in magnitude than those anticipated under the proposed action, because the changes that surround Alaska Native and rural non-Native sociocultural systems would have accumulated to a lesser degree than they would have over the full 30-year period. Certain complicating factors make it impossible to determine precisely how much less in magnitude the impacts would be, and if the change would be in impacts related specifically to the TAPS.

Identifying and measuring variables precisely in sociocultural systems is difficult. First, the variables of potential interest are often qualitative (beliefs, behavioral patterns, etc.) and difficult to gauge or evaluate in terms of levels at a particular point in time and rate of change over time. Second, the contribution to modernization in Alaska by the TAPS (as opposed to other sources) is unclear, as it is under the proposed action. That is to say, although modernization in Alaska is clearly linked to the oil industry, and by extension to the TAPS, many changes occur by way of indirect economic development or changes brought about by this indirect development. Attributing a precise amount of modernization, assumed to be a major vehicle of sociocultural change, to the TAPS under a 30-year renewal or a renewal of less than 30 years is a very uncertain process. Third, the nature of the rate of impact accumulation is unclear. For example, it is unclear if sociocultural change caused by a TAPS ROW grant renewal is constant or occurs in a different manner over time — perhaps more slowly earlier and more rapidly as changes in surrounding lifestyles accumulate (or vice versa).

Finally, the discussions and treatment of sociocultural impacts have, in a sense, dealt with sociocultural *systems* as a single sort of entity, when in fact there are several systems to deal with in the vicinity of the TAPS. Although there is a clear distinction between Alaska Native and non-Native sociocultural systems, there are also key differences among the various Native sociocultural systems. The impacts of the TAPS on one sociocultural system may differ considerably from its impacts on another, as may the accumulations on rates of change. As discussed in Section 3.25, all of the sociocultural systems considered in this EIS have changed considerably over the past century.

Some impacts to Alaska Native and rural non-Native sociocultural systems are anticipated under a ROW grant renewal of less than 30 years. Certain impacts possibly associated with modernization would be positive, such as access to improved health care, modern education, and other public services and programs on which rural sociocultural systems in Alaska have come to rely. Other impacts possibly in some way associated with modernization would be negative; increased substance abuse, high suicide rates, and social disruption accompanying increased participation in wage labor are examples discussed for the proposed action. In all cases, these changes appear to be linked to continued exposure to outside influences, growing importance of a cash economy, and increased integration into a modern market-based Euro-American society of people who, until the second half of the 20th century, often were largely isolated from continuous outside influence. The magnitude of sociocultural impacts would likely increase with time — that is, the impacts to sociocultural systems from a 25-year renewal likely would be greater than the impacts from a 15-year renewal. When all considerations are weighed, impacts to Alaska Native and rural non-Native sociocultural systems under a less-than-30-year alternative probably would be negative but very small.

4.5.2.22 Cultural Resources

The impacts associated with the less-than-30-year renewal alternative would be the same as those described for the proposed action (see Section 4.3.22). Adverse effects on known cultural resources are possible regardless of the length of the renewal period. Mitigation of the adverse effects is possible and would be determined on a case-by-case basis through consultation with the Alaska SHPO.

4.5.2.23 Land Uses and Coastal Zone Management

4.5.2.23.1 Land Use. The effects on land use or ownership under the less-than-

30-year renewal alternative would not differ from those for the proposed action (Section 4.3.23.1). Some effects on federal, state, and private land use or ownership would likely occur, regardless of the length of renewal. None of the impacting factors associated with renewal of the ROW or the effects that could potentially result would be time dependent.

4.5.2.23.2 Coastal Zone Management. The effects on coastal zone under the less-than-30-year renewal alternative would be the same as those of the proposed action (Section 4.3.23.2). The TAPS has been a permitted activity consistent with both the North Slope Borough and Valdez CMPs and in compliance with enforceable policies in both CMPs. The TAPS has also been a coastal zone development activity consistent with applicable ACMP statewide standards. Continued operation and maintenance of the TAPS is expected to continue to be consistent with statewide ACMP standards and the CMPs and in compliance with enforceable policies, regardless of the length of renewal.

4.5.2.24 Recreation, Wilderness, and Aesthetics

4.5.2.24.1 Recreation. The effects on recreation resources from renewal of the Federal Grant for less than 30 years would not differ from those for the proposed action (Section 4.3.24.1). Some effects on recreation are likely on federal or state lands in the vicinity of the pipeline, regardless of the length of renewal.

4.5.2.24.2 Wilderness. The effects on wilderness from renewal of the Federal Grant for less than 30 years would be the same as those for the proposed action (Section 4.3.24.2). The currently existing indirect effects on wilderness would likely continue, regardless of the length of renewal. The potential for direct or indirect effects from a large volume spill would remain (Section 4.4.4.18).

4.5.2.24.3 Aesthetics. The effects on aesthetics from renewal of the grant for less than 30 years would not differ from those of the proposed action (Section 4.3.24.3). Localized impacts to visual resources would be expected to continue, regardless of the length of renewal.

4.5.2.25 Environmental Justice

As discussed in Section A.14 (Appendix A), the identification of noteworthy environmental justice concerns requires the presence of high and adverse impacts in other impact areas. Evaluations of anticipated environmental consequences under a grant renewal of less than 30 years do not identify any impacts under normal operating conditions that could be considered high and adverse (Table 4.5-2). In the absence of such impacts, no environmental justice impacts are expected, regardless of the presence of disproportionately high percentages of minority and low-income populations in areas that might experience effects from the TAPS (see Section 3.29).

TABLE 4.5-2 Summary of Anticipated Impacts under the Less-Than-30-Year Alternative

Issue Area	EIS Section	Summary of Impacts[a]
Soils and permafrost	4.5.2.2	Anticipated negative impacts would be localized and small; earthquake-triggered liquefaction could threaten the integrity of the TAPS, causing spills, but would be highly unlikely.
Seismicity	4.5.2.3	No anticipated negative impacts on the basis of earthquakes that have occurred since TAPS construction; soil liquefaction and landslides due to an extremely large earthquake could threaten the integrity of the TAPS, although the likelihood of this happening is unknown.
Sand, gravel, and quarry resources	4.5.2.4	Anticipated negative impacts would be localized and small and generally less than impacts anticipated under the proposed action.
Paleontology	4.5.2.5	No anticipated negative impacts.
Surface water impacts	4.5.2.6	Both anticipated direct and indirect negative impacts would be localized small, and temporary and generally less than impacts anticipated under the proposed action.
Groundwater resources	4.5.2.7	Both anticipated direct and indirect negative impacts would be localized and generally less than impacts anticipated under the proposed action.
Physical marine environment	4.5.2.8	Anticipated negative impacts may affect the physical marine environment, but they would affect it at acceptable levels similar to those already experienced under normal TAPS operations (and likely at lower levels, because of decreased throughput and improved waste treatment).
Air quality	4.5.2.9	Anticipated negative impacts are expected to lie within regulatory limits established for the TAPS, and within both federal and state ambient air quality standards; all would generally be less than impacts anticipated under the proposed action.
Noise	4.5.2.10	Anticipated negative impacts would likely be similar to those currently experienced during TAPS operations. Impacts from construction and maintenance would be greater than normal current levels but temporary and localized. Impacts on animals from flyovers would be localized.
Transportation	4.5.2.11	No anticipated negative impacts.
Hazardous materials and waste management	4.5.2.12	Anticipated negative impacts would be similar to those currently experienced, with the management of hazardous materials and waste occurring in accordance with existing permits, procedures, and regulations.

TABLE 4.5-2 (Cont.)

Issue Area	EIS Section	Summary of Impacts[a]
Human health and safety	4.5.2.13	The magnitude of all anticipated negative impacts to workers, including fatalities, injuries, and time lost due to injuries, would be similar to rates observed by the Bureau of Labor Statistics and the National Safety Council. Anticipated impacts to the public would be small; all impacts are anticipated to be proportional to the duration of this alternative when compared with the duration of the proposed action.
Biological resources	4.5.2.14 (Biological Resources, Overview), 4.5.2.15 (Terrestrial Vegetation and Wetlands), 4.5.2.16 (Fish), 4.5.2.17 (Birds and Terrestrial Mammals), and 4.5.2.18 (Threatened, Endangered, and Protected Species)	Anticipated negative impacts to vegetation would be small and localized. Anticipated negative impacts to fish are expected to be small and temporary, with no population-level impacts. Anticipated negative impacts to birds and terrestrial mammals are expected to be small and localized, with no population-level impacts. Anticipated negative impacts to threatened, endangered, and protected species are not expected to exceed population-level impacts accompanying natural variation.
Economics	4.5.2.19	Anticipated impacts would include slow growth of the gross state product, population, employment, personal income, and tax revenues over the renewal period. All would increase at rates less than those projected under the proposed action.
Subsistence	4.5.2.20	Anticipated impacts would include both positive and negative effects. The overall impact likely would be negative but small.
Sociocultural systems	4.5.2.21	Anticipated impacts would include both positive and negative effects. The overall impact likely would be negative but small. Impacts would be less than those anticipated under the proposed action.
Cultural resources	4.5.2.22	Any possible negative impacts would be mitigated through procedures developed in consultation with the Alaska SHPO.
Land use and coastal zone management	4.5.2.23	Anticipated negative impacts on land use and land ownership are expected to be minor. Anticipated negative impacts on coastal zone management are expected to remain in compliance with enforceable policies and applicable statewide standards.
Recreation, wilderness, and aesthetics	4.5.2.24	Anticipated negative impacts to recreation, wilderness, and aesthetics are expected to be continuations of those already occurring, all of which lie within acceptable levels.

a Impacts are summarized here for the convenience of the reader. Details of the impact evaluations could not be included because of space limitations; additional information may be found in the referenced EIS section.

4.6 No-Action Alternative Analysis

4.6.1 Summary Description of the No-Action Alternative

4.6.1.1 Description of Termination Activities and Long-Term Restoration of the TAPS ROW

The no-action alternative represents a decision not to renew the Federal Grant of ROW for the TAPS. Operation of the pipeline would cease, and termination activities would be instituted. Termination activities are generally defined as the dismantlement and removal of the TAPS and the initial restoration of the TAPS ROW. Termination would be followed by activities for long-term-restoration of the ROW. No specific plans or designs for termination activities currently exist, they would have to be developed before specific actions could be taken. Any decision on how termination would occur would be subject to further NEPA analysis of the available options. For purposes of impact analysis, however, experiences during the construction and operation of the TAPS and the policies and stipulations of the BLM and the State of Alaska can be used as the bases for the following broad assumptions regarding termination activities:

- All stipulations and regulations applicable to the TAPS, the TAPS ROW, and associated facilities and activities would be met.

- No new facilities would be constructed for termination activities.

- Existing transportation means (e.g., air strips, roads, railways, and ports) would be used to support the termination activities. The most likely port facilities for use in termination activities would be Valdez, Whittier, and Seward.

- All aboveground sections of the pipeline, valves, and their supporting structures would be removed to a depth of 1 ft below the existing grade or to the existing grade and covered with 2 ft of fill material.

- Pump stations would be used as work camps and staging areas for termination activities.

- Gravel pads and currently disturbed surface soils (e.g., access roads and workpads) would be left in place and restored to the extent possible by methods such as contouring and hydroseeding, subject to AO and SPC approval.

- Culverts and stream crossings would be removed and regraded. All other stream or river structures would remain in place.

- Belowground pipeline components would be cleared and cleaned of oil and residues, capped, and left in place in those sections where they would not interfere with other termination activities or planned land uses.

- Residual, surplus, and scrap materials would be reused or recycled to the extent possible, and waste materials would be disposed of in accordance with applicable regulations.

- Soil, water, and air resources would be protected in accordance with applicable regulations (e.g., storm-water controls and fugitive dust controls would be implemented).

- The Valdez Marine Terminal would be removed, and the area would be converted for other uses.

- Modification to the TAPS, the TAPS ROW, and associated facilities before current operations cease would be limited to routine maintenance and those changes required by stipulations and regulations.

It is estimated, on the basis of the time required to construct the TAPS and effort involved in common construction practices, that the termination activities would require about 6 years to complete. (Monitoring and maintenance in restored areas would continue for an extended period as follow-on actions.) Years 1 and 2 of termination activities would be devoted primarily to planning and design, with some limited preparatory field activities (e.g., preparing staging areas). The next 3 years (Years 3, 4, and 5) would involve dismantlement and removal of the TAPS and the Valdez Marine Terminal (beginning with purging and cleaning of the pipeline in Year 3) and initial restoration of the ROW. The final year (Year 6) would be used to close out the dismantlement and removal operations, to restore any remaining land areas, and to demobilize the remaining termination labor force. The restoration process would continue as a follow-on action for many years after termination was complete. Other follow-on activities would include monitoring and maintenance of any mitigation measures.

The termination activities would occur concurrently over various sections of the TAPS. No one area would be disturbed longer than needed to complete termination activities within that area. Access within the TAPS ROW would continue to be limited in areas where termination activities were in progress.

It is assumed that the TAPS would continue to operate until the end of the current ROW grant in 2004. It is further assumed that the planning and design for termination activities would begin following a decision not to renew the current TAPS ROW. Therefore, the actual beginning of dismantlement and removal would occur after Federal Grant termination in 2004. This timing would place the completion of termination activities in the year 2007 or beyond. The phases and possible time periods of the termination activities are summarized in Table 4.6-1.

4.6.1.2 Spill Scenarios under the No-Action Alternative

In assessing spill impacts for the no-action alternative, it was assumed that the pipeline and marine transportation aboveground facilities related to the TAPS would be removed during a 6-year termination period over four phases (see Table 4.6-2). During that time, major activities would involve the physical removal of equipment and subsequent transportation to disposal sites. The first phase of termination (Years 1 and 2) is for planning and design; therefore, the annual frequency of an oil spill would be the same as that under normal operations, as discussed for the proposed action, and is not repeated in this section. Phase 2 of termination would involve the cessation of the oil supply from the North Slope and the purging of the remaining crude oil from the pipeline. This would be implemented, by using kerosene as a solvent to clean the pipe of crude oil residue and then by using seawater with additives as a final wash. The kerosene would be transported to Prudhoe Bay for later injection into the TAPS. Although the shipments would take several months, the actual pipeline purge process is estimated to take less than 1 month. The final purge would be with seawater.

TABLE 4.6-1 Possible Durations of Termination Activities and Long-Term Restoration under the No-Action Alternative

Year	Phase	Description	Possible Dates
1	1	Planning and design	2002–2003
2	1	Planning and design	2003–2004
3	2	Purging and cleaning	2004
3	3	Dismantlement, removal, and restoration	2004–2005
4	3	Dismantlement, removal, and restoration	2005–2006
5	3	Dismantlement, removal, and restoration	2006–2007
6	4	Demobilization, closeout, and end of termination activities	2007–2008
Beyond Year 6		Follow-on restoration, mitigation, monitoring, and maintenance	2009 and beyond

TABLE 4.6-2 Summary of Spill Scenarios for the No-Action Alternative

				Frequency Range				Release (spill)			
Scenario No.	Scenario Description	Location	Estimated Frequency (1/year)	Anticipated (>0.5/yr)	Likely (0.03 to 0.5/yr)	Unlikely (10^{-4} to 0.03/yr)	Very Unlikely (10^{-6} to 10^{-4}/yr)	Chemical Form	Spill Volume (gal)	Release Duration	Release Point
Spill Scenario during Cleaning and Purging Stage of Termination (Phase 2: Year 3)											
1	*Tanker truck transport rollover:* Spill caused by a tanker truck overturning	On the road between the North Pole Refinery and Prudhoe Bay	7.8E+00	X				Kerosene	8,000	Instan-taneous	Above ground, on land
Pipeline Spill Scenarios during Three-Year Demolition Stage of Termination (Phase 3: Years 3 to 5)											
2	*Tanker truck transport rollover:* Spill caused by a tanker truck overturning.	Generally, somewhere on the haul road	6.2E-01	X				Diesel fuel	3,000	Instan-taneous	Above ground, on land
3	*Fuel handling:* Spill caused by tank overfill, due to worker negligence or inattention.	Pump stations and/or camps where the fuel is stored.	1.8E+00	X				Diesel fuel	250	Instan-taneous	Above ground, on land
4	*Fuel distribution:* Spill caused by failures of shutoff valves, fittings, etc., in storage facilities, distribution lines, and fuel trucks.	Pump stations and/or camps where the fuel is stored.	7.3E+00	X				Diesel fuel	20	Instan-taneous	Above ground, on land
5	*Demolition Activity:* Spills caused during demolition, such as a bulldozer breaking a fuel line or a oil barrel falling off a moving truck)	Near the workpad.	1.2E+01	X				Diesel fuel	50	Instan-taneous	Above ground, on land

TABLE 4.6-2 (Cont.)

Scenario No.	Scenario Description	Location	Estimated Frequency (1/year)	Frequency Range: Anticipated (>0.5/yr)	Likely (0.03 to 0.5/yr)	Unlikely (10^{-4} to 0.03/yr)	Very Unlikely (10^{-6} to 10^{-4}/yr)	Release (spill): Chemical Form	Spill Volume (gal)	Release Duration	Release Point
6	*Construction Equipment Failures:* Caused by mechanical failures of fuel lines, gaskets, hydraulic hoses, etc., of heavy equipment and vehicles.	Near the workpad	1.4E+01	X				Diesel fuel	50	Instan-taneous	Above ground, on land
Transportation Spill Scenarios during Three-Year Demolition Stage of Termination (Phase 3: Years 3 to 5)											
7	*Rail transport:* Diesel fuel spill during routine transport operations	Option 1 – Scrap material transport to Seward (rail)	6.8E-01	X				Diesel fuel	162	Instan-taneous	Above ground, on land
8	*Rail transport:* Diesel fuel spill during *routine transport* operations	Option 2 – Scrap material transport to Whittier (rail)	6.1E-01	X				Diesel fuel	162	Instan-taneous	Above ground, on land
9	*Rail transport:* Engine lube oil spill during routine transport operations	Option 1 – Scrap material transport to Seward (rail)	4.2E-01		X			Engine lube oil	14	Instan-taneous	Above ground, on land
10	*Rail transport:* Engine lube oil spill during routine transport operations	Option 2 – Scrap material transport to Whittier (rail)	3.8E-01		X			Engine lube oil	14	Instan-taneous	Above ground, on land
11	*Rail transport:* Hydraulic oil spill during routine transport operations	Option 1 – Scrap material transport to Seward (rail)	6.5E-01	X				Hydraulic oil	26	Instan-taneous	Above ground, on land
12	*Rail transport:* Hydraulic oil spill during routine transport operations	Option 2 - Scrap material transport to Whittier (rail)	5.8E-01	X				Hydraulic oil	26	Instan-taneous	Above ground, on land

Although no pipeline kerosene or seawater spill events would be credibly foreseeable, a transportation spill from tanker truck shipments of kerosene from the North Pole Refinery to Prudhoe Bay would be an anticipated spill. The termination activities conducted during Phase 3 would take around three years and could involve a variety of possible petroleum spills to the environment.

Possible spill events during all four phases of pipeline termination were evaluated. Since no segment of the pipeline has ever been subject to termination activities, no record of spill events was available for review. However, because termination would essentially be a large-scale construction project in reverse (APSC 2001), the construction period for the pipeline was used as a surrogate for developing spill scenarios. Data from the environmental surveillance of the TAPS during construction (APSC 1978) were used to develop a representative set of spill scenarios for termination of the pipeline. The only activities meeting the screening criteria for credible events identified in Section 4.4.1 were those that would be planned for Phases 2 and 3 of termination. Spill scenarios were developed for purging and cleaning and demolition activities that would occur starting in 2004 (the expiration year for the current Federal Grant of ROW) and ending in 2007. All the developed termination activity spill scenarios have frequencies that would characterize these events as “anticipated” or “likely” occurrences. None are considered to have “unlikely” or “very unlikely” frequencies as defined in Table 4.6-2. This is consistent with available published EISs covering the termination of oil and gas pipelines that have not addressed unlikely or extremely unlikely spills. Data were considered on activities prior to initiating crude oil pipeline transport, in addition to the use of these materials during TAPS facility operations. Similarly for spills under the proposed action, the analysis of termination-related spills under the no-action alternative considered spills of crude oil and refined petroleum products (e.g., gasoline, diesel fuel, and turbine fuel). Other specific materials that were known to be required for carrying out termination activities or incidentally used during those activities were also factored into the spills analysis. This included the need for and the projected use of kerosene and various fuels during termination activities, the large amounts of kerosene needed for purging and cleaning the pipeline, and various hydraulic and lubricating oils.

Table 4.6-2 summarizes the 12 TAPS termination-related spill scenarios considered in this DEIS. Scenario 1 covers the period during the cessation of product flow and system washout (i.e., cleaning and purging stage). Scenarios 2 through 5 pertain to the removal of aboveground facilities (i.e., demolition stage). The table provides (1) a brief description of each spill scenario, (2) best estimate of frequency, (3) frequency range, (4) description of the material spilled (chemical form), (4) spill volume, (5) release duration, and (6) release point (above or belowground). The given spill scenario frequencies are specific to the entire length (i.e., 800 mi) of pipeline during the termination period. Frequencies were computed for each pipeline scenario, and each scenario was assigned a likelihood category with the specific assigned frequencies and frequency ranges given in Table 4.6-2. The assigned frequencies were estimated on the basis of TAPS construction statistics that were weighted by the ratio of the amount of diesel fuel that would be used during TAPS termination to the amount that was used during TAPS construction. For all 12 spill scenarios, it is estimated that the release would occur very quickly, with a duration on the order of 1 hour or less. Such quick releases are designated as instantaneous releases. All spill scenarios represent aboveground land-based events. Ten of the 12 termination spills evaluated would be attributable to human error. The remaining two, Scenarios 4 and 6, would be caused by equipment failure.

An estimated volume of over 7 million gal of kerosene needed for pipeline purging and cleaning would be shipped to the North Slope by liquid kerosene tanker trucks. A total of over 900 shipments in 8,000-gal bulk containers would be needed. The largest spill (Scenario 1) analyzed would be caused by human error, which would result in an accident involving a fuel truck carrying kerosene from the Williams North Pole Refinery to Prudhoe Bay. The truck veers off the highway, overturns, and spills the solvent on the ground. With a truck accident frequency of about eight per year, a spill involving

8,000 gal of kerosene would be anticipated. The spill would be projected to occur on an approximately 450-mi stretch of highway connecting the refinery and North Slope. In addition to the kerosene highway transportation spill, a total of 11 other credible spill events are possible for termination activities conducted during Phase 3. Seven are due to transportation vehicle accidents, two from fuel handling and distribution, and one during demolition activities. One of the remaining transportation spills (Scenario 2) involves a highway diesel oil spill from a haul road tank wagon rollover. The six other transportation events involve rail shipments of pipeline scrap material to either Seward or Whittier, Alaska. These spills would involve relatively small quantities of diesel fuel (around 160 gal), hydraulic oil (less than 15 gal), and engine lubricating oil (less than 30 gal). The spills would occur near the rail track and would have frequencies of either an anticipated or likely event, on the basis of examination of historical Alaska rail accidents (Alaska Railroad 2002).

The fuel handling accident (Scenario 3) would be caused by worker distraction or negligence. The error causes a tank to overfill, resulting in a spill of 250 gal of diesel oil. The event presumably occurs at a pump station and/or camp where the fuel is stored. The event frequency is 7.4 per year. The remaining human error initiated spill (Scenario 5) occurs during demolition activities involving a bulldozer breaking a fuel line or an oil barrel falling off a moving truck, resulting in a 50-gal diesel fuel spill. The spill event presumably occurs near a work pad with a relatively high event frequency of 50 per year.

The last two termination activity scenarios (Scenarios 4 and 6) are due to an indirect human initiator. These include one spill involving equipment failure and one involving fuel handling or distribution. The equipment failure spill (Scenario 4) is caused by a mechanical failure in a fuel line, gasket, or hydraulic hose connection with heavy equipment on a workpad. As in Scenario 3, the fuel handling accident, Scenario 4 also presumably occurs at a pump station and/or camp where the diesel fuel is stored. This event, however, involves a spill of only 20 gal of fuel, but with a likelihood that would be over a factor of 3 greater than the tank overflow spill (Scenario 3). The construction equipment failure spill event (Scenario 6) would be caused by failures of shutoff valves or fittings in storage facilities, or distribution lines or fuel trucks. This event would presumably occur near a workpad and would also have a relatively small spill size of around 50 gal of diesel fuel. The estimated frequency of this event is very high, over 50 per year.

Catastrophic spill scenarios of the type assessed for the proposed action alternative were also considered to be extremely rare and, therefore, were screened from further analysis as incredible events.

4.6.2 Impact Analysis of the No-Action Alternative

4.6.2.1 Physiography and Geology

Under the no-action alternative, the physiography along the TAPS ROW would not be altered. Thus, this alternative would have no impact on physiography during the entire extent of termination activities.

Impacts of No-Action Alternative on Physiography and Geology

During the first two years of preparatory work for termination activities, the impact on geological resources would not be changed measurably from that expected for the proposed action. The dismantlement and removal of the TAPS would cause minor change in geological processes and in the removal of geologic material along the TAPS ROW.

The impact on geology during the first two years of termination activities would be comparable to those of the proposed action. During that initial period, the activities in the field would be limited to minor preparatory work and regular maintenance. The preparatory activities in the field would not be expected to disturb the ground surface. Geologic material removed from

TAPS facilities would be used for regular maintenance. The geological processes along the TAPS would not be changed measurably.

During the dismantlement and removal of the TAPS, some activities — such as dismantling the aboveground pipeline, pump stations, and Valdez Marine Terminal; contouring pump station gravel pads and access roads; and contouring the terminal pad and access roads — would involve movements of heavy equipment and disturbance of the ground surface. These activities would increase soil erosion locally along the aboveground pipelines, pump stations, and Valdez Marine Terminal. The impacts would be minor and localized.

4.6.2.2 Soils and Permafrost

During the preparatory phase (Years 1 and 2) of termination activities, the slopes, VSMs, and workpads would be maintained as usual (TAPS Owners 2001a) and preparatory work in the field would be minimal. Excavations for rerouting pipeline, corrosion digs, replacing valves, repairing buried pipe, and refurbishing pipeline coating would continue as part of routine maintenance for the TAPS. The impacts on the soils and permafrost would be about the same as those from the proposed action, and the affected areas would also be the same. The impacts would be local and small.

During the actual dismantlement and removal of TAPS (Years 3 through 5), heavy equipment would be used along the aboveground portions of the pipeline. The pump stations would be used as staging areas. The traffic involved with moving heavy equipment along the TAPS ROW, the dismantlement operations to remove aboveground structures, and regrading would destroy previously stabilized local vegetation (also see Section 4.6.2.15). These activities would also affect the soils and degrade previously stabilized permafrost, thereby producing soil compaction, soil erosion, siltation, altered soil hydrology, ponding, thermokarst, and slope stability problems. Best management practices would be used, including installing silt fences, settling basins, and water bars. Water bars are 2- to 3-ft high, diagonal ridges built of dirt on sloped ground intended to slow runoff water and direct it to areas of soil that are not bare, thereby reducing surface soil erosion (West Virginia University Extension Service 2002). Additional practices should be used to minimize disturbance of vegetative cover. The extent of the impacts would likely be local, limited to areas adjacent to the aboveground portions of the pipeline and access roads.

The area of land that would be disturbed is estimated to be 4,525 acres, including the aboveground pipeline workpad (3,151 acres), access roads (534 acres), stream banks and valve sites (190 acres), gravel pads at pump stations (300 acres), and the Valdez Marine Terminal site (350 acres) (Folga et al. 2002). The disturbed land is expected to be rehabilitated by regrading and reseeding. The regrading activities would temporarily increase soil erosion and siltation in nearby water bodies. Because most of the aboveground pipeline is located in permafrost-unstable areas that may have reached thermal equilibrium after 25 years of operation, the dismantlement and removal of TAPS would redisturb the thermal regime of the

Impacts of No-Action Alternative on Soils and Permafrost

During the preparatory phase of termination, the impacts on soils and permafrost would be about the same as those from the proposed action – local and small. During TAPS dismantlement and removal, impacts would likely be local, limited to areas adjacent to aboveground portions of the pipeline and access roads. The area of land that would be disturbed is estimated to be 4,525 acres. Restoration of the disturbed land would involve regrading and reseeding. The regrading would temporarily increase soil erosion and siltation in nearby water bodies. In addition, the dismantlement and removal of TAPS components would redisturb the thermal regime of the surface soil. With time, the belowground pipeline segments left in place would become corroded and collapse. Ground depressions might be created above such collapses. The potential impacts of spills on soils would be much smaller under the no-action alternative than under the proposed action.

surface soil. These areas would be exposed to lowering of the permafrost table, melting of ground ice, increased soil saturation, and possible surface ponding. Thermokarst topography may result.

After the crude oil stopped flowing, heat transfer from the warm oil in the belowground pipeline to its surroundings would cease. In permafrost areas, thaw bulbs that had originally formed around the pipeline would shrink, and permafrost would aggrade slowly. The aggradation would also be affected by the nature of soil materials and the magnitude of ground surface disturbance during the dismantlement. Frost heaving would occur in soils near the TAPS, especially in areas where fine-grained material was dominant in the subsurface and water was available. The aggradation and frost heaving processes would be reduced by the warming climate changes in Alaska. It is estimated that the impact on soils from the change of heat flow in the belowground pipeline would be local and minor.

With time, the belowground pipeline segments left in place would become corroded and collapse. Ground depressions might be created above such collapses. In areas where the groundwater table was shallow or surface drainage water collected, water might pond in the depressions. It is also possible that the deteriorating belowground pipeline would provide an additional conduit beside the surrounding gravel for groundwater movement.

Accidental spills and leaks could affect the environment. In the first two years under the no-action alternative, the potential impacts on the environment caused by spills would be the same as those for the proposed action (see Sections 4.3.2 and 4.4.4.1). Six spill scenarios are identified for the cleaning and purging and demolition stages (see Table 4.6-2).

The spills analyzed for the no-action alternative would involve kerosene and diesel fuel. Kerosene is volatile. If a spill of kerosene occurred, a substantial amount of it would evaporate into the air. Because the spill volumes would be much smaller and the products involved in the spills would be more volatile under the no-action alternative than under the proposed action, the potential impacts of spills on soils would be much smaller under the no-action alternative.

4.6.2.3 Seismicity

Seismicity-related issues of concern would be earthquake-triggered events that could threaten the integrity of the pipeline and storage facilities while they still contained oil, causing environmental contamination. Once the pipeline was drained of oil and cleaned and once storage facilities were removed (as outlined in TAPS Owners 2001a), the threat of TAPS-related spills caused by earthquakes would be eliminated.

4.6.2.4 Sand, Gravel, and Quarry Resources

Under the no-action alternative, the demand for sand, gravel, and quarry stones used to maintain the TAPS in the first 2 years of termination activities would be the same as under the proposed action, but these materials would no longer be needed after the preparatory phase of the termination activities. Therefore, the impacts from removing these materials would be much smaller for the no-action alternative than for the proposed action.

The material sites may remain active after the TAPS termination and be used by the State of Alaska. Top soil resources may be required for revegetation of some disturbed areas, depending on site-specific conditions. (See Section 4.6.2.15 for additional information on revegetation.)

4.6.2.5 Paleontology

No adverse effects on paleontological resources are anticipated under the no-action alternative. Although 11 localities with paleontological resources have been found within a quarter mile of the ROW, and sections of the ROW closely parallel scientifically important fossil-bearing strata, no localities with paleontological resources are known to exist in the ROW and associated areas. Under Federal Grant Stipulation 1.9.2, APSC would have to immediately contact the JPO Authorized Officer and an archaeologist (who would, in turn,

Impacts of No-Action Alternative on Paleontological Resources

No adverse effects on paleontological resources are anticipated under the no-action alternative, although ground disturbance during dismantlement might damage or obscure previously undiscovered, scientifically important paleontological resources.

contact a qualified paleontologist) if any known or previously undiscovered paleontological resources were encountered during termination activities. Alaska's Historic Preservation Statute 41.35 also protects paleontological resources that might be encountered on state-administered land during termination. The likelihood of encountering paleontological resources is low because ground disturbance during termination would be limited largely and, perhaps, exclusively to lands already disturbed during TAPS construction. Lesser, but still adverse, effects could include the obscuring or damage of previously unknown paleontological resources during pipeline removal efforts. However, the absence of the pipeline would remove the need for continual ground-disturbing activities along the TAPS and associated areas, as well as eliminate the threat of an oil spill requiring cleanup activities, thus lessening the likelihood of adverse impacts to paleontological resources.

4.6.2.6 Surface Water Resources

Under the no-action alternative, fresh surface water resources along the TAPS ROW could be affected by activities associated with the termination activities — dismantling the pipeline system, removing the dismantled pieces, and restoring the area by contouring and hydroseeding. Accidental releases of oil or other materials would be possible during these processes. Cleaning and purging the pipeline would start in Year 3, after a 2-year planning period. Dismantling the pipeline, pump stations, and Valdez Marine Terminal, and disposing of scrap would occur during Years 3–5. Impacts during the first 2 years are assumed to be the same as those for the proposed action. It is assumed that the constraints described in Section 4.6.1.1 would apply during pipeline termination.

Relative to surface water resources, the main impacting factors of the termination would include water use along the ROW, digging to remove some underground components of the pipeline, removing segments of the aboveground pipeline and other aboveground facilities, spills, and other accidental releases. These impacting factors could:

- Modify rivers and streams by erosion, deposition, migration, and flow restriction;
- Create ponding and flooding;
- Drain and create thaw lakes;
- Degrade surface water quality;
- Reduce surface water resources;
- Spread surface contamination;
- Disturb permafrost;
- Change the number, size, and connectivity of thermokarsts along the ROW; and
- Remove geologic resources.

During the termination activities, the physical environment could also affect the TAPS. Impacting factors would include the following:

- Earthquakes;
- Glacial movements (surges and retreats);
- Solifluction (i.e., a slow-motion debris flow caused by seasonal freeze/thaw of the active layer interacting with the pull of gravity downslope);
- Mud flows;
- Increased permafrost temperatures resulting from general warming of Alaska; and
- Other hazards such as debris flows, landslides, rock falls, slumps, and floods.

Impacts of No-Action Alternative on Surface Water Resources

Direct impacts to surface water resources along the TAPS ROW for the no-action alternative could result from water use and spills. Groundwater wells along the ROW would not be able to provide all of the water needed for termination activities. For the peak year, about 500 gal/min of surface water would be needed. If withdrawn from a river such as the Tanana, which has a flow range of 110,000 to 450,000 gal/min, the withdrawals would be a small fraction of the water available. In addition, the withdrawals would be made under the guidelines of a permit, ensuring that the impacts on the quantity of surface water would not adversely affect the environment. During the termination process, impacts from spills would be the same as those for the proposed action until the oil is removed from the pipeline. Because many miles of river banks and beds could be coated with oil, the impacts could be large. Once the oil is removed from the pipeline, the most severe accident postulated would involve an 8,000-gal release of kerosene. Because evaporation of the spilled kerosene would limit the extent of contamination, impacts from this type of accident are considered to be minor.

Indirect impacts to surface water resources for the no-action alternative could occur by discharging water to the land, with subsequent runoff to nearby surface water bodies. The quality of the runoff water would be regulated under appropriate permits, and best management practices would be used to limit the quantities of contaminants leaving construction sites. Impacts to water quality would be similar to those that occurred during construction of the pipeline. These impacts would be local and temporary.

Impacts from these processes would be the same as those discussed previously for the proposed action (Section 4.3.6).

The water use anticipated for the termination activities is listed in Tables 4.6-3 (potable uses) and 4.6-4 (process uses). Most of the water use would occur during actual cleaning and purging of the pipeline; dismantling the pipeline, pump stations, and Valdez Marine Terminal; and disposing of scrap. The greatest use would occur in the third year of termination activities. Table 3.1-1 shows that the groundwater well system along the TAPS ROW could provide a total of about 277,000 gal/d of potable water. This quantity of water would be insufficient to meet the average demand during the third and fourth years of termination and would provide only about one-third of peak-day consumption (about 700,000 gal/d) during the third year. Additional water would probably be obtained from surface water resources by pumping it into tanker trucks and hauling it to the locations needed. An additional 5,000 gal/d of process water would be required for dust suppression and seeding and sodding (Table 4.6-4). This water also would be obtained from surface water resources and trucked, as needed. Because the amount of excess water needed for termination activities would be small (about 500 gal/min for the peak day during the third year) and would be withdrawn under the guidelines of a permit, impacts on the quantity of surface water would be negligible.

During termination activities, surface water quality could be affected by runoff from construction areas, and by surface spills and other accidental releases. Dismantling the pipeline and removing some buried pipeline sections adjacent to river training structures could increase the quantity of sediment in nearby water bodies. Removal activities would be regulated by the linewide NPDES, Wastewater General Permit, and the NPDES Permit for Storm Water Discharge from Construction Activities Associated with Industrial Activity discussed in Section 3.7.2.5 (Surface Water Quality along the ROW). Impacts from removal activities are expected to be temporary, particularly in high-sediment-load streams, because best management practices would be used. These practices could include installing settling basins and silt fences, keeping roads and machinery out of streams and floodplains, placing culverts at stream crossings, stabilizing disturbed stream banks, using dust suppression, and, as required, installing water bars. (See Section 4.6.2.2 for a definition of water bar.)

TABLE 4.6-3 Anticipated Potable Water Use during Termination Activities

Year	Average Day (gal/d)	Peak Day (gal/d)	Annual (gal)
1	23,000	31,000	4,700,000
2	55,000	74,000	14,000,000
3	520,000	700,000	130,000,000
4	330,000	450,000	80,000,000
5	190,000	260,000	48,000,000
6	56,000	75,000	14,000,000
Total	1,174,000	1,590,000	290,700,000

Source: Folga et al. (2002).

TABLE 4.6-4 Anticipated Process Water Use during Pipeline Dismantlement and Removal Phase (Years 3–5)

	Water Use (gal) by Location					
Activity	Southern Section[a]	Central Section[b]	Northern Section[c]	Valdez Marine Terminal	Total	Water per Acre (gal/acre)
Dust suppression	1,257,000	1,594,000	1,324,000	350,000	4,525,000	1,000
Seeding and sodding	269,000	323,000	132,000	350,000	1,074,000	1,000
Total	1,526,000	1,917,000	1,456,000	700,000	5,599,000	NA[d]
Annual use (for Years 3–5)	509,000	639,000	485,000	233,000	1,866,000	NA

[a] Southern Section refers to the section of the pipeline between MP 494 and 799.

[b] Central Section refers to the section of the pipeline between MP 244 and 493.

[c] Northern Section refers to the section of the pipeline between MP 0 and 243.

[d] NA = not applicable.

Source: Folga et al. (2002).

Activities involving removal of dismantled TAPS components during termination could also impact surface water quality by providing sources of contamination that could be mobilized by precipitation and transported overland to nearby water bodies. Possible contaminants would include fuels, lubricants, bitumens, organic compounds, hazardous construction material, and cleaning materials. The quality of the runoff water from the removal areas would be regulated by the above NPDES permits, and best management practices would again be used to limit the quantity of contaminants leaving the construction sites. Some possible best management practices include storing construction material away from nearby surface water bodies and their floodplains, covering construction materials to minimize interaction with rainfall, thoroughly cleaning up any spills as soon as they occur, placing fueling and vehicle service areas away from nearby surface water bodies and berming the areas to minimize transport by runoff, and disposing of waste materials properly (USDA 2000). Impacts are expected to be local and temporary.

The no-action alternative could also result in some long-term impacts (in 20 or more years) on surface water resources. In areas where belowground portions of the pipeline were left in place, corrosion could cause a collapse of the pipeline and draining of adjacent wetlands as the breached pipe filled with water. The quantity of water that would be lost from the surface would depend on the length of the buried pipe that would fill with water. For a 1-mi section of pipe, about 1.5 acre-ft of water (1 acre of surface area covered by water to a depth of 1 ft) could be lost from the surface. The magnitude of this loss would be negligible compared with the quantity of water occurring along the TAPS ROW.

Spill scenarios have been proposed for the no-action alternative. These accidents are described in Table 4.6-2. All of the accidents would have an occurrence frequency of greater than 0.5/yr. In the most severe accident, a tanker truck carrying kerosene from the Williams North Pole Refinery to Prudhoe Bay would overturn, spilling 190 bbl (8,000 gal) of kerosene. Kerosene is a common type of fuel oil and is a crude-oil product. The release is assumed to be instantaneous. This type of accident could impact surface water resources, especially if the kerosene was spilled directly into the water.

The impacts of this accident would be similar to those previously evaluated for an instantaneous release of crude oil from the pipeline at an elevated river crossing resulting from a small leak (anticipated spill event). For the anticipated spill scenario, the volume of fluid released to the streams and rivers would be about the same: 50 versus 190 bbl. Recovery response times for the truck rollover incident would be the same as those used for the anticipated spill scenario. If the spill occurred into one of the six previously evaluated rivers and creeks (Section 4.4.4.3), potential recovery of the kerosene at the designated containment sites would occur for the Gulkana River and Minton Creek under low-flow conditions. At the other rivers (Sagavanirktok, Yukon, Tanana, and Tazlina), the entire contents of the spilled truck would move past the containment site before initiation of recovery activities under conditions of plug flow and no degradation.

Some chemicals found in fuel oils may evaporate easily, while others may more easily dissolve in water. Spills of products such as kerosene, gasoline, and diesel fuel, which contain lighter components, might evaporate completely within a few hours (American Petroleum Institute 2002). Because of its low density (about 0.8 g/cm^3) and low solubility in water, the released kerosene would float on the water surface and move downstream (Baker 2001). Emulsification, which could increase the kerosene's effective life, would not be expected to occur (Hayes et al. 1992). As the kerosene moved downstream, a substantial amount would evaporate before reaching the containment site. This degradation would significantly reduce the impacts of the spill on the surface water resources; impacts would then be limited to a short distance downstream from the location of the spill.

Following dismantling of the pipeline and other surface facilities, the ground would be rehabilitated to the extent possible by methods such as contouring and hydroseeding. The process of hydroseeding would begin with seeds of native plants, fertilizer, a tackifier (basically a glue), and some medium such as cellulose or wood fiber (or a 50/50 mix of these two) being combined in a machine. This mixture would then be force-applied to the soil in an effort to keep the mixture in place until the seeds germinated. The root structure of the plants would then bind the soil together, preventing wind or rain erosion. The process is particularly well suited to hillsides or slopes, where rills and ruts induce further wind and rain erosion. Surface water impacts associated with this portion of the termination process would be negligible and would primarily relate to the amount of process water needed. Once the land surfaces were restored, there would be no further adverse impacts on surface water resources.

4.6.2.7 Groundwater Resources

If the no-action alternative was selected, groundwater resources along the TAPS ROW could be impacted by termination activities that would include dismantling the pipeline system, removing the dismantled pieces, and restoring the area by contouring and hydroseeding. Cleaning and purging the pipeline would start after a 2-year planning and preparation process. Dismantling the pipeline, pump stations, and the Valdez Marine Terminal and disposing of scrap would start 3 years after the beginning of the termination process and would continue for 3 years. Impacts during the first 2 years would be the same as those for the proposed action. During pipeline termination, the constraints described in Section 4.6.1.1 would apply.

Relative to groundwater resources, the main impacting factors of the termination process would include water use along the ROW, digging to remove some underground components of the pipeline, removing segments of the aboveground pipeline and other aboveground facilities, and potential spills and other accidental releases. These impacting factors could (1) change the depth to groundwater, (2) modify its direction of flow, (3) deplete the quantity available, and (4) degrade its quality.

The physical environment could also affect the TAPS during termination activities and produce groundwater impacts for the no-action alternative. Impacting factors include the following:

- Earthquakes;
- Glacial movements (surges and retreats);
- Solifluction (i.e., a slow-motion debris flow caused by seasonal freeze/thaw of the active layer interacting with the pull of gravity downslope);
- Mud flows;
- Global warming; and
- Other hazards such as debris flows, landslides, rock falls, slumps, and floods.

Impacts on groundwater from these processes would be the same as those discussed previously for the proposed action (Section 4.3.7) and would be limited to the preparatory period of the termination process when oil or kerosene and seawater would still be flowing in the pipeline. Once the flow in the pipeline ceased, these impacting factors would no longer be applicable.

As discussed in Section 4.6.2.6, water would be needed for the no-action alternative (Table 4.6-3). Most of the water use would occur during the actual cleaning and purging of the pipeline; dismantling of the pipeline, pump stations, and the Valdez Marine Terminal; and the disposal of scrap. The greatest use would

Impacts of No-Action Alternative on Groundwater Resources

Under the no-action alternative, direct impacts on groundwater resources could result from extraction of groundwater for operational needs. Because the groundwater that would be used for termination activities would be obtained from existing wells, without changes to the number of wells pumping or their extraction rates, impacts to groundwater resources would be similar to those for the proposed action and historical operations. These impacts would be minor and local.

Indirect impacts on groundwater resources for the no-action alternative could occur through infiltration of contaminated surface water and water from septic fields. Historically, groundwater impacts from surface contamination have been local because of the presence of permafrost that limits deep percolation of contaminated water, the assimilation properties of the groundwater, and adherence to guidelines specified in the linewide NPDES permit. Because the activities associated with the no-action alternative would produce impacts similar to those observed historically, the impacts would also be similar.

Historically, septic fields have been used to dispose of sanitary wastewater at PS 7, 9, 10, and 12. Impacts on groundwater from these systems have been local, and other groundwater users along the TAPS ROW have not been affected. Use of these facilities during the termination process would produce similar impacts.

occur in the third year of termination activities. Most of this water would be obtained from surface water; the remainder would come from wells. Table 3.1-1 shows that the groundwater well system along the TAPS ROW could provide a total of about 277,000 gal/d of potable water. Because the quantity of groundwater that would be used for termination activities would be supplied by the existing TAPS wells, without modification to the number of wells pumping or their extraction rates, groundwater conditions (i.e., depth to groundwater, flow direction, and quantity available) would not be affected. At the end of the termination period, water would no longer be needed, and extraction would cease.

Although the impacts to underlying aquifers would not change as the result of termination activities, liquid groundwater in the form of thaw bulbs along the TAPS ROW would be lost as the water refroze in the absence of heat from the warm oil flowing in the pipeline. However, because the water in the thaw bulbs is not used as a resource outside of TAPS, its loss would have no impact on any external users.

As discussed above, the physical properties of the groundwater along the TAPS ROW would not be impacted during the termination period; however, its chemical composition could be indirectly affected by infiltration of contaminated surface water from construction areas and from locations of surface spills and other accidental releases. There would be no direct impacts to groundwater quality because there are no plans for disposing of contaminated water in wells.

Section 4.6.2.6 discusses the impacts of removal activities during pipeline termination. These activities could impact surface water quality by providing sources of contamination that could be mobilized by precipitation and transported overland to nearby water bodies. Possible contaminants include fuels, lubricants, bitumens, organic compounds, hazardous construction materials, cleaning materials, and sanitary wastewater disposed of in septic fields. Contaminated surface water could then infiltrate the ground and affect groundwater resources. However, the quality of the runoff water from the removal areas would be regulated by NPDES permits, and best management practices would be used to limit the quantity of contaminants leaving the construction sites in the dissolved phase. Some possible best management practices include storing construction material away from nearby surface water bodies and their floodplains, covering construction materials to minimize interaction with rainfall, thoroughly cleaning up any spills as soon as they occur, locating fueling and vehicle service areas away from nearby surface water bodies and berming the area to minimize transport by runoff, and disposing of waste materials properly (USDA 2000). Implementation of these best management practices would minimize impacts to the groundwater. In addition, use of septic fields during the termination process would produce impacts similar to those that have historically occurred. Those impacts have been local and have not affected other groundwater users along the TAPS ROW.

Spill scenarios have been proposed for the no-action alternative. These accidents are described in Table 4.6-2. In the most severe accident scenario, a tanker truck carrying kerosene from the Williams North Pole Refinery to Prudhoe Bay is assumed to overturn and spill 190 bbl (8,000 gal) of kerosene. Kerosene is a common type of fuel oil and is a crude-oil product. The release is assumed to be instantaneous. This type of accident could indirectly impact groundwater resources through infiltration of the kerosene.

Because of its high volatility, kerosene (and other light diesel fuels) would quickly evaporate following a rollover spill (American Petroleum Institute 2002). By quickly cleaning up any remaining kerosene and contaminated surface soil after the spill, indirect impacts to underlying groundwater would not be measurable.

Following dismantling of the pipeline and other surface facilities, the ground would be rehabilitated to the extent possible. Such methods as contouring and hydroseeding would be used. If the reseeded areas were watered artificially, infiltration and recharge to the underlying groundwater could increase. Because the volume of water anticipated for reseeding is small relative to the total quantity of water needed, these increases would produce a negligible impact on existing groundwater resources.

4.6.2.8 Physical Marine Environment

Physical marine resources could be affected by activities associated with the termination process under the no-action alternative. The areas considered in this analysis are Port Valdez, Prince William Sound, and nearby locations that have the potential to be affected, such as the Port of Seward. Direct impacts considered are impacts that would be caused by the no-action alternative and occur at the same time and place. Indirect impacts would also be caused by the no-action alternative, but they would occur later in time or be located farther in distance from the associated activities.

Relative to the physical marine environment, the main impacting factors associated with termination activities would include processing of waste and wash water at the Valdez Marine Terminal; accidents and spills that could result in releases to the marine environment; digging to remove structures, which could increase erosion and sediment transport into the marine environment; dock and ship operations for the transport of waste and scrap from the ports of Valdez, Whittier, and Seward; potential marine accidents during the transport of waste and scrap; and removal activities associated with the Valdez Marine Terminal docks that could potentially disturb marine sediments. These impacting factors could:

- Increase sediment releases to Port Valdez,
- Disturb sediments and mobilize contaminants in Port Valdez,
- Release hydrocarbons to Port Valdez, and
- Release sediments and other contaminants to the marine environments near the ports of Valdez, Whitier, and Seward.

During the termination activities, the physical environment could also affect the TAPS and Valdez Marine Terminal. Impacting factors would include:

- Earthquakes,
- Storm events (flooding) that could accelerate runoff and sediment release,
- Tsunamis, and
- Glacial calving in Prince William Sound that could impact marine traffic associated with termination activities.

4.6.2.8.1 Discharges from the Valdez Marine Terminal. Discharges at the Valdez Marine Terminal during the termination activities for the terminal and TAPS could impact physical marine resources. The materials that could be discharged from the Valdez Marine Terminal during termination activities can be divided into the following categories: industrial wastewater, domestic sanitary wastewater, and storm water, which includes sediment from termination activities. It is assumed that the BWTF at the Valdez Marine Terminal would continue to operate and treat waste and wash water resulting from the termination activities. The sanitary water treatment plant would also continue to operate. Regulatory permits govern

Impacts of No-Action Alternative on Physical Marine Environment

Impacts from Valdez Marine Terminal releases resulting from termination activities under the no-action alternative would be generally smaller than historical impacts. However, while historical releases have been continuous, releases under the no-action alternative would be temporary and cease with the completion of termination activities.

The impacts to physical marine resources from scrap metal transport would be short-lived and would cease with the completion of termination activities.

Major accidents that could occur under the no-action alternative would be similar to those discussed for the proposed action. The potential for tanker accidents to occur would end once oil shipments ceased.

the types, quantities, and methods of treatment or best management practices applicable to each wastewater discharge, as discussed in Section 3.16.4. These permits would have to be modified to address the new influent source (purge water) for the BWTF. The two permitted outfalls from the Valdez Marine Terminal are from the BWTF and the sanitary water treatment plant, both of which discharge into Port Valdez and are covered by an NPDES permit (see Section 3.1.2.1.3). Treated wastewater is discharged into Port Valdez through a diffuser near the bottom of the fjord. The diffuser mixes the discharged wastewater with the surrounding waters. Effluent limitations for these outfalls are established for flow rate, biochemical oxygen demand (BOD_5, which is BOD measured over a 5-day period), TSS, and pH. The NPDES permit also establishes a mixing zone and effluent monitoring requirements.

During the third year of the termination activities, 397 million gal of seawater would be used to clean the pipeline (Folga et al. 2002). The resulting wastewater, containing about 0.02% by volume crude oil, would be treated at the BWTF. This waste would be similar to the oily bilge water currently treated by the BWTF. The treated effluent from this wastewater would be released to Port Valdez. In addition, slightly more than 2 million gal of an alkaline solution with various surfactants would be used to clean residual oily waste from the pipeline. This wastewater would also be treated at the BWTF. The alkaline solution would be mixed with chemicals such as trisodium phosphate, nonaqueous surfactants, and aqueous surfactants at 10% by weight (Folga et al. 2002).

The current capacity of the BWTF would be sufficient to treat this volume of water, and the storage tanks at the Valdez Marine Terminal could be used, if needed, for temporary storage. The total BWTF effluent flow for the year 2000 was 3.785 billion gal, about 10.3 million gal/d (see Appendix C), with historical maximum monthly volumes of about 15 million gal/d.

Under the no-action alternative, effluent volumes from the BWTF would be significantly reduced from current and historic levels. For the first 2 years, releases would continue similar to historic volumes, and in the last 3 years of termination activities, no treated water would be released. In the third year of termination activities, water related to purging, cleaning, and removing the pipeline would be treated. The volume released in the third year would be approximately one-tenth of existing release volumes with similar constituents. The sanitary water treatment plant would continue to operate throughout the termination period; its release levels would be similar to historical release levels.

The impacting factors for this treated wastewater resulting from termination activities would not differ significantly from those associated with historical operations. After treatment, the effluent would be released through the existing diffuser into the waters of Port Valdez and monitored under a modified NPDES permit.

Termination activities at the Valdez Marine Terminal and along the TAPS could increase sediment loads in surface runoff during construction activities near Port Valdez. These impacts would be largest during Years 3–5 of the termination period, structures and facilities at the Valdez Marine Terminal would be removed and the site would be regraded and vegetated. Approximately 350 acres would be regraded and seeded at the Valdez Marine Terminal during termination activities under the no-action alternative (Folga et al. 2002).

The impacts from the increase in sediments resulting from termination activities and subsequent regrading and reseeding under the no-action alternative could be minimized by following standard construction practices and following the stipulations in the required construction permits. As discussed in Section 3.7.2.5, storm-water runoff that could carry sediments from these activities is regulated under the EPA Storm Water Multi-Sector General NPDES Permit. This permit is intended to ensure that storm-water runoff has no significant adverse impact on the environment. The termination activities would also be governed by the NPDES permit for Storm Water Discharge from Construction Activities Associated with Industrial Activity, which applies to construction activities that disturb more than 5 acres, do not involve excavation dewatering, and have a potential to impact waters of the United States. Specific notices of intent must be submitted to the EPA, and projects that meet the criteria for coverage under this permit must comply with the stipulations contained in the permit.

Impacts from Valdez Marine Terminal releases resulting from termination activities under the no-action alternative would be generally smaller than historic impacts. However, while historical releases have been continuous, releases under the no-action alternative would be temporary and cease with the completion of termination activities. Treated wastewater volumes would be reduced in the third year of termination to approximately one-tenth of historical annual volumes, with no releases in Years 4–6. However, the wastewater resulting from pipe cleaning operations would contain various additives, such as trisodium phosphate and various aqueous and nonaqueous surfactants, that could affect treatment procedures at the BWTF (Folga et al. 2002).

Future impacts from Valdez Marine Terminal releases during normal operations under the no-action alternative would be short-lived: 2 years of normal operations, 1 year for releases of treated wastewater effluent from pipe purging, and 6 years for releases from the sanitary water treatment plant. The impacts from sediment loads would occur in Years 4–6 of termination activities and continue until vegetation was sufficiently established to minimize erosion from disturbed areas.

4.6.2.8.2 Impacts at Ports. Some of the scrap metal resulting from termination of the TAPS would be transported to the ports of Valdez and Seward (or Whittier) and loaded on ships for marine transport to disposal or processing locations. At the ports of Seward and Valdez, 70-acre scrap yards would be used to store scrap metal prior to shipment (Folga et al. 2002). Operation and construction of these scrap yards could generate sediments that could impact the marine environment. In addition, any chemical or fuel spills that occurred in these yards could potentially reach the marine environment.

The impacts of these potential releases could be mitigated if the scrap yards operated in accordance with all applicable permits. The potential impacts from additional sediments or other contaminants resulting from operation and construction of the scrap yards would cease with the completion of termination activities and removal of the accumulated scrap.

4.6.2.8.3 Termination-Associated Marine Transportation. The amounts of scrap metal that would be sent to ports for transport during the termination period are expected to be slightly more than 10,000 tons per year at Seward and slightly less than 10,000 tons per year at Port Valdez. Potential impacting factors to physical marine resources from this transportation would include small hydrocarbon emissions that could be released by ships in the marine environment, dock operations, the physical transit of the ships through coastal waters such as Prince William Sound, and docking at Port Valdez and the Port of Seward.

The annual tonnage of scrap metal would not significantly increase ship traffic at either port, and the minor increases would be short-lived, lasting only during Years 4–6 of termination activities. In addition, tanker visits to the Valdez Marine Terminal would cease with the beginning of termination activities, significantly reducing TAPS-generated marine traffic in Prince William Sound and Port Valdez.

The impacts to physical marine resources from scrap metal transport would be short-lived and would cease with the completion of termination activities.

4.6.2.8.4 Accidents. Major accidents that could occur under the no-action alternative are similar to those discussed for the proposed action in Section 4.4.4.5. The potential for a large oil spill would be mitigated once oil delivery was completed and the storage tanks at the Valdez Marine Terminal were emptied. Both events would occur near the beginning of termination activities. The potential for tanker accidents would also cease to exist once oil shipments had ceased.

4.6.2.8.5 Impacts of the Physical Environment on the TAPS. Several environmental factors could impact TAPS under the no-action alternative. These factors would include tsunamis, earthquakes, floods or high rainfall events, and icebergs from glacier calving that could affect marine traffic. In general, the impacts from these factors would be the same as those under the affected environment (Section 3.9). The potential for these impacts would decrease as termination activities progressed.

Once oil deliveries had ceased and the storage tanks at the Valdez Marine Terminal were emptied, TAPS-related marine tanker traffic would cease. Some minimal marine traffic involved in the transport of scrap metal could potentially be impacted by icebergs, but those impacts would be short-lived and would cease with the completion of termination activities and the removal of the scrap.

The potential impacts from earthquakes and tsunamis would continue, but when storage tanks and the pipeline were drained of oil, the risks associated with any of these events would decrease below current levels. These impacts would cease with the completion of termination activities.

4.6.2.9 Air Quality

This section describes the estimated potential impacts on air quality (in terms of criteria pollutants and HAPs) and on the AQRVs of visibility and acid deposition that could occur in the vicinity of TAPS facilities (pipeline, pump stations, and Valdez Marine Terminal) during the 6-year termination activity period under the no-action alternative.

During Years 1 and 2, before the pipeline would be shut down, activities that would result in emissions would include the normal operation of TAPS facilities and planning, mobilization, and preparatory construction for dismantling and removing TAPS facilities. Air quality and AQRV impacts resulting from TAPS-related emissions during this 2-year period would be similar to those during current TAPS operation, as described in Section 4.3.9.

During Years 3 through 5, the termination activities for TAPS facilities would include cleaning and purging the pipeline, dismantling aboveground facilities along the pipeline and at pump stations and the Valdez Marine Terminal, removing wastes and scrap materials for recycling or disposal, and restoring disturbed land. Because the level of activities that would result in emissions would probably be highest during the third year of the termination activities (Folga et al. 2002, Tables VE1 and HP1), the estimated potential impacts during the third year of the termination activity period are described here.

Activities during Year 6 would involve the demobilization of equipment and personnel. Potential emissions and resulting impacts during this period would be substantially less than those from the termination activities during Years 3 through 5. At the end of the 6-year period, all emissions resulting from TAPS-related activities would cease for all practical purposes, and, as a result, there would be no more air quality and AQRV impacts from the TAPS.

Impacts of No-Action Alternative on Air Quality

The potential impacts on air quality and air quality-related values (AQRVs) — visibility and acid deposition — resulting from emissions associated with TAPS during termination activities are estimated to be (1) similar to those estimated for the proposed action during the first 2 years of termination (when TAPS facilities would be operated normally); (2) less than those estimated to result under the proposed action during Years 3 to 5 of the termination activities because emissions would be less; and (3) much less than those estimated to result under the proposed action during Year 6 of termination activities, when emissions would be limited to those associated with demobilization of equipment and personnel utilized in termination activities.

Emission sources of criteria pollutants, HAPs, and volatile organic compounds (VOCs) during the third year of termination activity would include the following:

- Exhaust emissions from turbine generators at pump stations during pipeline cleaning and purging,
- Exhaust and fugitive dust emissions from heavy equipment during dismantling and restoration,
- Exhaust emissions from incinerators operated to dispose of municipal solid waste generated by the termination activity workforce, and
- Exhaust and road dust emissions from vehicles and locomotives used to transport workers, supplies, wastes, and scrap materials.

4.6.2.9.1 Criteria Pollutants. Data on estimated potential emissions of criteria pollutants (SO_2, NO_x, CO, and PM_{10}) and VOCs from equipment exhaust gas and from the fugitive dust generated by various termination activities are presented in Table 4.6-5 as annual total emissions from three pipeline sections,[1] pump stations, and the Valdez Marine Terminal. For vehicle-related emissions, they are listed according to the types of items transported or roads traveled on.

The largest emission source category during termination activities (excluding the period of pipeline cleaning and purging) would be the exhaust gas from heavy equipment used in dismantling and restoration. Dismantling processes would include removing fiberglass insulation and clamping insulation modules; cutting and lowering pipe and clamping pipe assemblies to the ground; removing and stockpiling radiators; and removing and stockpiling VSMs and heat pipes. Restoration processes that would immediately follow dismantling would include regrading and reseeding. The exhaust gas from vehicles and locomotives used to transport workers, wastes, and scrap materials would be the next largest category of emission sources. Emissions from the remaining source category (exhaust gas from the mainline turbine generators and other fuel uses during pipeline cleaning and purging) would be relatively small when compared with the emissions from the other two source categories. Estimated potential air quality and AQVR impacts resulting from each source category are described below.

Cleaning and Purging the Pipeline. Cleaning and purging of the pipeline would start at the beginning of Year 3 and last for only about 1 month. During this period, levels of activities that would result in emissions would be similar to levels during normal TAPS operation involving crude oil transport. Although kerosene (for cleaning) and seawater (for purging) rather than crude oil would be moving through the pipeline, emissions from the mainline turbine generators would not exceed the permitted potential maximum emissions from these sources. Other emissions from pump stations and Valdez Marine Terminal operations would be similar to or less than the emissions during normal TAPS operation (see Table 4.6-5). Therefore, it is estimated that potential air quality and AQVR impacts during this period would be similar to or less than impacts occurring during the period of normal TAPS operation.

Dismantling and Restoration. Termination activities that would occur after the cleaning and purging of the pipeline are assumed to be performed at three pipeline sections — northern, central, and southern — and at the Valdez Marine Terminal. Two separate crews would be involved at each of the three pipeline sections and at Valdez Marine Terminal. At each pipeline section, termination activities would progress southward, with one crew starting from the northern end of the section and the other starting from the middle. At Valdez Marine Terminal, termination activities would be performed at two different parts of the

[1] Termination activities that would occur after the cleaning and purging of the pipeline are assumed to be simultaneously performed at three pipeline sections — northern, central, and southern — and at the Valdez Marine Terminal.

TABLE 4.6-5 Estimated Potential Average Annual Emissions of Criteria Pollutants and Volatile Organic Compounds from Termination Activities

Termination Activity	Emission Type and Source	Location or Activity Type	Annual Emission Rate (tons/yr)				
			SO_2	NO_x	CO	PM_{10}	VOCs
Cleaning and purging pipeline[a]	Exhaust emissions from turbine generators and other TAPS facilities	All pump stations and Valdez Marine Terminal	544.3	966.1	350.3	101.8	318.4
Dismantling and restoration[b]	Exhaust emissions from fuel used for heavy equipment and other miscellaneous purposes	Northern	25.3	186.5	92.5	15.0	15.6
		Central	24.8	184.2	86.3	16.5	18.8
		Southern	18.8	132.4	65.3	12.2	13.1
		Valdez Marine Terminal	30.5	222.0	115.6	20.1	22.0
		Total	99.4	725.1	359.7	63.9	69.5
	Fugitive dust from land being disturbed during regrading and reseeding	Northern	–[c]	–	–	4.8	–
		Central	–	–	–	5.7	–
		Southern	–	–	–	4.5	–
		Valdez Marine Terminal	–	–	–	1.3	–
		Total	–	–	–	16.3	–
	Exhaust emissions from municipal solid waste incineration		28.8	28.8	2.6	3.1	–
	Total dismantling and restoration		128.2	753.9	362.3	83.3	69.5
Removal and transport[b]	Exhaust emissions from vehicles and locomotives	Workers by truck	0.5	4.1	33.9	0.9	2.3
		Waste by truck	1.1	15.7	24.2	1.6	2.7
		Scrap materials by truck	1.4	20.0	30.9	2.1	3.4
		Scrap materials by rail[d]	31.3	292.0	43.6	11.0	17.3
		Total	34.3	331.8	132.6	15.6	25.7
	Road dust from vehicles	Paved road	–	–	–	358	–
		Unpaved road	–	–	–	3,152	–
		Total	–	–	–	3,510	–
	Total removal and transport		34.3	331.8	132.6	3,526	25.7
Total			706.8	2,051.8	845.2	3,711.1	413.6

a Emissions during 1-month period of pipeline cleaning and purging are assumed to be one-twelfth the annual emission values for normal TAPS operation presented in Table 3.13-3. These estimates are conservatively high because all TAPS facilities would not be operating at full load during this period.

b Peak-year emissions can be estimated by increasing average-year emissions by 33.3%.

c A dash indicates no emissions or data not available.

d For rail transport to Seward.

Source: Folga et al. (2002, Tables CE1, CE2, IE1, and VE1).

site. Thus, there would be eight separate emission source locations (i.e., termination activity sites). Potential annual emissions from one of the two termination activity sites in each pipeline section and the Valdez Marine Terminal would be approximately half of those listed in Table 4.6-5 for dismantling and restoration activities. Therefore, the highest annual emissions at any of the six termination activity sites along the pipeline (two sites at each of the northern, central, and southern sections as specified in Table 4.6-5) would be approximately 13, 93, 46, 8, and 9 tons/yr for SO_2, NO_x, CO, PM_{10}, and VOCs, respectively. These values are on the same order of magnitude as the lowest potential annual emissions of each pollutant among all pump stations under TAPS operation, at 2.1 million bbl/d of crude oil throughput (i.e., 12, 175, 50, 33, and 8 tons/yr for SO_2, NO_x, CO, PM_{10}, and VOCs, respectively; see Table 3.13-3). The total estimated potential annual emissions at the two termination activity sites within the Valdez Marine Terminal would be approximately 31, 222, 116, 21, and 22 tons/yr for SO_2, NO_x, CO, PM_{10}, and VOCs, respectively (Table 4.6-5), corresponding to about 2, 14, 85, 8, and 0.6%, respectively, of the potential annual emissions from the Valdez Marine Terminal under TAPS operation, at 2.1 million bbl/d of crude oil throughput.

The termination activity sites along the TAPS pipeline would be moving continuously, and those within the Valdez Marine Terminal would also be moving around within the terminal boundary during the termination activity period. On the basis of approximately 420 mi of aboveground pipeline, two termination activity sites per pipeline section, and 3 years with 240 working days per year, the termination activity sites along the pipeline would be moving southward at an average rate of about 0.1 mi (510 ft) per day, or 2.9 mi (15,400 ft) per month. (This estimate ignores the time needed for termination activities at pump stations. Thus, the time available for pipeline termination activities would be shorter, and, consequently, the actual rate of the termination activity site movement along the pipeline would be faster while pipeline termination activities were actually being performed.) Because of the continuous movement of termination activity sites along the pipeline, any given receptor along the pipeline would be subjected to peak air quality impacts resulting from emissions from termination activities for only a short period.

The magnitude of potential emissions of each criteria pollutant from each termination activity site along the pipeline or the termination activity sites at Valdez Marine Terminal would be smaller on a monthly basis than those from the TAPS main pipeline replacement project at the upper Atigun River floodplain performed over a 4-month period in 1990 (see Section 4.3.9.1). That project required more extensive earth moving than would the dismantling and restoration activities under the no-action alternative. Thus, potential impacts on ambient air quality at a given receptor location that would result from emissions from individual termination activity sites would be short term, would be limited to the immediate vicinity of the activity sites, and would not cause ambient air quality to exceed applicable ambient air quality standards.

Removal and Transport. Sources of emissions associated with the transport of workers, wastes, and scrap materials for recycling and disposal would include light-duty and heavy-duty vehicles and freight trains. Workers involved in termination activities would be transported daily on buses between termination activity sites and living quarters at pump stations, the Valdez Marine Terminal, and other temporary housing units. Various waste materials generated from the dismantling processes would be shipped by truck to commercial landfill sites, ADEC-approved disposal sites, or special out-of-state disposal sites, depending on the type of waste. For this analysis, it is assumed that scrap materials from north of MP 492 would be trucked to Fairbanks and then shipped by rail to Seward (or Whittier), Alaska, and that scrap materials from south of MP 492 would be trucked directly to Valdez. The scrap materials consolidated at scrap yards in Seward (or Whittier) and Valdez would be loaded on ships for disposition at locations outside Alaska.

Table 4.6-6 presents the estimated number of round trips, round-trip distances, emission factors, and annual exhaust and road dust emissions of criteria pollutants and VOCs for the vehicles and locomotives that would be used to

TABLE 4.6-6 Estimated Potential Average Annual Emissions of Criteria Pollutants and Volatile Organic Compounds from Vehicular and Rail Traffic[a]

Transport Mode	No. of Round Trips	Round Trip Distance (mi)	Emission Type	Emission Factor[b] (g/mi)					Annual Emission Rate (tons/yr)				
				SO_2	NO_x	CO	PM_{10}	VOCs	SO_2	NO_x	CO	PM_{10}	VOCs
Workers by bus	83,912	92	Exhaust	0.06	0.41	2.56	0.11	0.13	0.5	4.1	33.9	0.9	2.3
			Road dust	–[c]	–	–	–	–	–	–	–	1,314	–
Waste by truck	8,518	370	Exhaust	0.31	4.51	6.96	0.47	0.77	1.1	15.7	24.2	1.6	2.7
			Road dust	–	–	–	–	–	–	–	–	807	–
Scrap materials by truck	10,908	370	Exhaust	0.31	4.51	6.96	0.47	0.77	1.4	20.0	30.9	2.1	3.4
			Road dust	–	–	–	–	–	–	–	–	1,165	–
Scrap materials by rail[d]	219	960	Exhaust	19.1	178	26.6	6.7	10.5	31.3	292.0	43.6	1.6	17.3
			Road dust	–	–	–	–	–	–	–	–	224	–
Total exhaust emissions									34.3	331.8	132.6	6.2	25.7
Total road dust emissions									–	–	–	3,510	–
Total emissions									34.3	331.8	132.6	3,516.2	25.7

[a] For transporting workers, wastes, and scrap materials. Peak-year emissions can be estimated by increasing average-year emissions by 33.3%.

[b] Emission factors for rail locomotives are in g/gal of diesel fuel consumed. Fuel efficiency for the locomotive is assumed to be 0.14 mi/gal.

[c] A dash indicates no emissions or data not available.

[d] Emissions from transport to the scrap yard at Valdez. Emissions from transporting scrap materials to Whittier would be less (about 90% of the values for the Valdez case).

Source: Folga (2002, Table VE1).

transport the workers, wastes, and scrap materials during termination activities. The annual numbers of round trips during the third year of termination activities are estimated to be 83,912 to transport workers by bus, 8,518 to transport wastes by truck, 10,908 to transport scrap materials by truck, and 219 transport scrap materials by rail.

On the basis of eight termination activity crews and 240 working days per year with one 12-hour shift per day, the 83,912 round trips per year for transporting workers represent about 44 round trips per day (22 in the morning and 22 in the evening) on the road between each termination activity site and pump station or temporary housing unit living quarters. If all morning or evening commuting took place in 1 hour, the number of commuting vehicles on this road would average approximately one vehicle per minute during that hour. At the Valdez Marine Terminal, with its two termination activity crews, this number would double. By assuming two destinations (Fairbanks and Valdez) and 240 working days per year with 12 hours of operation per day, the 8,518 and 10,908 round trips per year to transport wastes and scrap materials, respectively, by truck represent an average of about 18 and 23 round trips per day, or approximately 2 round trips per hour for both cases, on the roads between the termination activity sites and Fairbanks or Valdez.

The numbers of vehicles traveling on a per-day or per-hour basis estimated above are small. Therefore, potential air quality impacts caused by emissions from these vehicles would be hardly measurable in terms of hourly or daily average ambient concentrations. Although it is estimated that the frequency of rail traffic for shipping scrap materials from Fairbanks to Seward (or Whittier) would be much less than the frequency of truck traffic for transporting wastes and scrap materials (about 2.4 one-way trips per day or 1.2 round trip per day, respectively), estimated annual emissions of criteria pollutants and VOCs from rail traffic would be on the same order of magnitude as the emissions from truck traffic. Thus, potential air quality impacts caused by emissions from rail traffic would be on the same order of magnitude as those due to truck traffic.

4.6.2.9.2 Hazardous Air Pollutants. Table 4.6-7 presents the estimated potential emissions of HAPs (benzene, toluene, ethyl benzene, xylene, n-hexane, trimethyl pentane, acrolein, acetaldehyde, formaldehyde, naphthalene, and 1,3-butadiene) from equipment exhaust gas associated with various termination activities. The estimated HAPS emissions resulting from dismantling, restoration, removal, and transport activities during the termination period would be small fractions of the estimated potential annual emissions of HAPs from normal operations of TAPS facilities (Table 3.13-6), except for acetaldehyde, formaldehyde, and 1,3 butadiene. However, it is estimated that ambient impacts of these emissions would be small because the estimated annual emission rates would be very small in absolute terms (less than 2 tons/yr at each termination activity site along the pipeline or at Valdez Marine Terminal) and because they would be released over a large area.

4.6.2.9.3 Visibility. Water vapor emitted from equipment and vehicle operations at termination activity sites would have the potential to contribute to periodic episodes of ice fog, which can occur during the winter when ambient temperatures are −20°F or colder. Ice fog can cause serious problems in areas prone to it, such as the Fairbanks/North Pole area. However, the termination activity sites where equipment and vehicles would be operated would be in remote, uninhabited areas most of the time. Even when the sites would be near population centers, the probability of the ambient temperature reaching −20°F or less would be very small. Thus, although the combination of a low temperature of −20°F or colder and the presence of one of the termination activity sites near an area prone to ice fog could occur, the probability of such an occurrence would be very small.

During Year 3 of termination activities, estimated potential emissions of SO_2 and NO_x (precursors of aerosols that cause visibility impairment) would be only small fractions of the estimated potential emissions of those materials during normal operations of TAPS facilities under the proposed action. The emissions of SO_2 and NO_x during Year 3 of termination would

TABLE 4.6-7 Estimated Potential Average Annual Emissions of Hazardous Air Pollutants from Termination Activities

			Annual Emission Rate (tons/yr)											
Termination Activity	Source of Exhaust Emissions	Location or Activity Type	Benzene	Toluene	Ethyl Benzene	Xylene	n-Hexane	Trimethyl-pentane	Acrolein	Acet-aldehyde	Form-aldehyde	Nephtha-lene	1,3-Buta-diene	Total
Cleaning and purging pipeline[a]	Turbine generators and other TAPS facilities	All pump stations and Valdez Marine Terminal	4.16	3.54	0.31	1.93	3.69	1.51	0.003	0.06	0.76	0.50	0.003	16.47
Dismantling and restoration[b]	Fuel used for heavy equipment and other purposes	Northern	0.32	0.23	0.05	0.16	0.02	–[c]	0.18	1.16	2.33	0.001	0.03	4.48
		Central	0.38	0.28	0.06	0.20	0.03	–	0.22	1.39	2.81	0.001	0.03	5.40
		Southern	0.27	0.20	0.04	0.14	0.02	–	0.15	0.98	1.96	0.001	0.02	3.78
		Valdez Marine Terminal	0.45	0.33	0.07	0.23	0.03	–	0.25	1.63	3.28	0.001	0.04	6.31
		Total dismantling and restoration	1.42	1.04	0.22	0.73	0.10	1.51	0.80	5.16	10.38	0.004	0.12	19.97
Removal and transport	Vehicles and locomotives	Workers by truck	0.03	0.01	0.00	0.01	0.01	–	0.01	0.08	0.22	0.000	0.02	0.39
		Waste by truck	0.03	0.01	0.01	0.01	0.01	–	0.01	0.10	0.26	0.000	0.02	0.55
		Scrap materials by truck	0.04	0.01	0.01	0.02	0.02	–	0.01	0.12	0.33	0.000	0.03	0.59
		Scrap materials by rail	0.16	0.05	0.05	0.03	0.09	–	0.06	0.15	2.46	0.027	0.25	3.36
		Total removal and transport	0.26	0.08	0.08	0.05	0.13	–	0.09	0.45	3.27	0.027	0.32	4.80
Total			5.84	4.66	0.58	2.78	3.92	1.51	0.89	5.67	14.41	0.531	0.443	41.23

[a] Emissions during 1-month period of pipeline cleaning and purging, which are one-twelfth the annual emission values for normal TAPS operation presented in Table 3.13-3. These are conservatively high estimates because all TAPS facilities were assumed to be operating at full load during this period.

[b] Peak-year emissions can be estimated by increasing average-year emissions by 33.3%.

[c] A dash indicates no data are available.

Source: Folga (2002, Table HP1).

amount to an estimated 710 and 2,050 tons/yr (respectively), compared with releases of 6,500 and 11,600 tons/yr, respectively, during normal TAPS operations (Tables 3.13-3 and 4.6-5).

Excluding ground-level emissions of road dust, the estimated potential emissions of particulate matter (PM_{10}) from termination activities (about 200 tons/yr) would also be a small fraction of PM_{10} emissions from TAPS facilities under the proposed action (about 1,200 tons/yr). Therefore, it is estimated that any potential impacts of visibility-impairing pollutant emissions that would result from termination activities would be less than those that would occur under the proposed action, which were predicted not to cause any adverse visibility impacts at visibility-sensitive Class I and Class II areas in the vicinity of TAPS facilities (Section 4.3.9.3.2).

4.6.2.9.4 Acid Deposition. Acid deposition results from the long-range transport and chemical conversion of precursors (primarily SO_2 and NO_x) and deposition of the resulting acidic species (primarily sulfate and nitrate). Thus, the level of precursor emissions from TAPS facilities serves as a good indicator of the degree of impacts that TAPS could have on acid deposition at sensitive receptors in the vicinity of TAPS facilities. Potential emissions of acid deposition precursors from the termination activities under the no-action alternative are estimated to be only a small fraction of the precursor emissions from all existing TAPS facilities under the proposed action. As indicated above, it is estimated that potential emissions from all termination activities during the peak emission year under the no-action alternative would be about 710 tons/yr of SO_2 and 2,050 tons/yr of NO_x (Table 4.6-5), while those emissions from all TAPS facilities under the proposed action would be about 6,500 tons/yr of SO_2 and 11,600 tons/yr of NO_x (Table 3.13-3). Section 4.3.9.4 concludes that acid deposition from TAPS facilities under the proposed action would be minor. It is estimated that potential impacts on acid deposition caused by precursor emissions from termination activities under the no-action alternative would be even smaller.

4.6.2.10 Noise

This section describes the estimated potential noise and vibration impacts that could occur in the vicinity of TAPS facilities (pipeline, pump stations, and Valdez Marine Terminal) as a result of termination activities under the no-action alternative. During the 6-year termination period, the activities that would result in the highest level of noise and vibration would occur during the third year (Folga et al. 2002, Tables UT1, WF1). Thus, the estimated potential noise impacts during the third year of termination activities are described here. Potential impacts during the remaining years of termination would be less. At the end of the termination activities, all noise and vibration from TAPS-related activities would cease.

Impacts of the No-Action Alternative on Noise

The activities affecting ambient noise levels in the vicinity of TAPS facilities would be at their peak during Year 3 of the 6-year termination period under the no-action alternative. The potential impacts on noise during Year 3 are estimated to be similar to those occurring during normal TAPS facility operation and construction (for repair, maintenance, and system upgrades) under the proposed action. Noise impacts resulting from TAPS termination activities during other years of the 6-year termination period would be less. Blasting large concrete structures at Valdez Marine Terminal with explosives during Years 3 to 5 of the termination activities would cause ground vibration and airblast overpressure (manifested in the blast wave from an explosion). No damages to structures or impacts on animals from airblast overpressure are anticipated.

During the third year of termination activities when pipeline cleaning and purging would occur, noise emissions from TAPS facilities would be similar to those under the proposed action. After completion of cleaning and purging, dismantling and restoration activities are assumed to start at six sites along the pipeline and at two sites within the Valdez Marine Terminal (Section 4.6.2.9.1). Noise emitted from equipment and vehicles operated at each of these sites would be similar to noise emitted from typical large construction sites. Potential impacts of such noise would be similar to impacts caused by noise emitted from construction activities associated with TAPS repairs, maintenance, and future system upgrades under the proposed action, as described in Section 4.3.10.

Upon completion of the pipeline cleaning and purging process, pipeline operation and use of fixed-wing aircraft and helicopters for surveillance would cease, eliminating those noise sources.

As part of termination activities, large concrete structures at the Valdez Marine Terminal would be demolished with explosives. These structures include containment walls at the East and West Tank Farms and at the fuel tanks in the Power/Vapor Recovery Area, and the retaining wall at the Ballast Water Treatment Facility. About 10,000 linear ft of concrete walls would be demolished at these locations (Folga et al. 2002, Table E1) during Years 3 through 5 of termination. The potential impacts of the blasting at the Valdez Marine Terminal on ground vibration and airblast overpressure were estimated by assuming 112 blasts would be set off at a time delay of 8-millisecond intervals for a 1 lb unit charge of dynamite per hole with a diameter of 2 in. and a depth of 2 ft.

The peak particle velocity (PPV) or the velocity of ground movement is generally accepted as the best indicator of the potential for structural damage. The results of the analysis using the procedures described in Appendix A, Section A.4.2 indicate that the PPV at a receptor location beyond 20 ft from the blast site would not exceed 2 in. per second, a value considered safe for poor plaster. The PPV at the residential area about 2 mi east of the Valdez Marine Terminal is estimated to be 0.0002 in. per second; therefore, no impacts from ground vibration would be anticipated as a result of the blasting of concrete structures at the Valdez Marine Terminal.

The airblast overpressure is estimated to be equal to or less than 0.0001 psi for the case of the base zone (the zone most likely to be along the propagation path) at the residential area about 2 mi east of the Valdez Marine Terminal. This value is about one-hundredth of the threshold value that may cause damage to farms or wildlife (0.02 psi). Therefore, no impacts from airblast overpressure would be anticipated from the blasting of concrete structures at the Valdez Marine Terminal.

4.6.2.11 Transportation

Termination activities, as described in Section 4.6.2.1, would require logistics support (including transportation) similar to that needed for pipeline construction. The current pump stations would serve as bases of operations for restoring the ROW, as did the original work camps for constructing the TAPS. However, rather than construction materials being shipped to work site locations, scrap and waste materials would be shipped from work site locations.

Impacts of No-Action Alternative on Transportation

The current transportation infrastructure in Alaska is adequate to handle termination activities. The highway and rail networks that provide support to TAPS operations would be expected to experience lower levels of traffic during termination activities except for the immediate vicinity of current operations. Air traffic to areas north of Fairbanks might increase slightly during this period to handle the transport needs of the increased workforce. After termination activities have been completed, air and highway traffic north of Fairbanks would be greatly decreased because of the reduced support needs for TAPS operations. Rail operations in the state would also be reduced since fuel trains from the Fairbanks area to Anchorage would be significantly reduced because of a decline in refinery operations associated with TAPS oil.

During the first two years of termination activities in preparation of dismantling and removing the pipeline, transportation-related impacts would be the same as those described for normal operations under the proposed action. The sixth year would focus on demobilization and close-out activities. Therefore, the following discussion of transportation-related impacts of termination focuses on activities during Years 3 through 5.

4.6.2.11.1 Aviation. An additional work force of approximately 3,300 people beyond the current average workforce of about 1,800 people required for total pipeline-related activity would be needed at one point during termination activities (APSC 2001i). Most of these personnel would need to be flown to and from the pump stations for termination activities. Air transport of some supplies might also be required.

After termination activities were finished, airports near the pipeline north of Fairbanks — especially Deadhorse Airport — would be greatly affected, since much of their operations have been geared toward support of pipeline activities.

4.6.2.11.2 Marine. As discussed further in Section 4.6.2.11.4, scrap metal from dismantling the pipeline would eventually be shipped back to the Lower 48 States via the ports at Valdez, Seward, and possibly Whittier. Materials and supplies for pipeline operations do not constitute a significant portion of goods that pass through the various Alaskan ports. Thus, operations in the major ports of Seward and Anchorage would not be significantly affected by a pipeline shutdown. On the other hand, shutdown of the pipeline would have a major impact on the Port of Valdez and operations in the Prince William Sound area. Tanker traffic would be eliminated, and the supporting service vessel operations, including SERVS, would be reduced or eliminated. SERVS is highly integrated with the local fishing communities and, aside from its tanker escort duties, provides emergency response capabilities for aiding vessels in distress.

4.6.2.11.3 Rail. The termination activities themselves would not have a significant impact on railroad operations. Current railroad activities in support of pipeline operations are few, as would be those in support of proposed shipments during termination (mentioned in the following section on road transport). However, the shutdown of the pipeline would have a significant overall impact on the railroad caused by a significant reduction in the amount of crude oil processed at the refineries in the Fairbanks area and at Valdez because the primary source of crude (TAPS) would no longer be available. As discussed in Section 4.3.11.3, approximately one-third of the Alaska Railroad's annual revenue is derived from petroleum shipments that are a direct result of the refinery operations in Alaska.

4.6.2.11.4 Road. Following its shutdown, the pipeline would be cleaned by running separate passes of kerosene and then seawater through it. Approximately 7,350,000 gal of kerosene would be needed for this effort (Folga et al. 2002, Table UT1); thus, about 565 tanker truck shipments of 13,000 gal each would need to be made to PS 1 before pipeline dismantlement.

Once dismantlement of the pipeline began, workers would need to be transported an average of 46 mi each way by bus from the pump stations to the work sites. It is estimated that about 83,912 round trips to and from the work sites would take place on an annual basis (Folga et al. 2002, Table VE1).

It is assumed for analysis, that salvageable steel from the pipeline north of MP 492 would be sent by truck to a scrap metal yard near Fairbanks. From Fairbanks, the scrap metal would be shipped by rail to Seward or possibly Whittier for eventual shipment by barge to the Lower 48 States. Approximately 4,664 truck shipments to Fairbanks (at an average distance of 185 mi per shipment) and 219 rail shipments of four railcars each from Fairbanks to Seward (a distance of 476 mi) would be required annually (Folga et al. 2002, Table VE1). It is also possible that a portion of this scrap might be sent to Whittier rather than Seward. It is assumed that salvageable steel from the pipeline south of MP 492, including the Valdez Marine Terminal, would be shipped to a scrap metal yard near Valdez for eventual shipment by boat to the Lower 48 States. Approximately 4,231 truck shipments (at an average distance of 185 mi per shipment) would be required (Folga et al. 2002, Table VE1).

Each year, wastes generated by pipeline removal operations — primarily liquid sanitary wastes (see Table 4.6-8) — would require approximately 8,518 shipments at an average distance of 185 mi per shipment (Folga et al. 2002, Table VE1). Demolished concrete from termination activities at TAPS facilities, including the Valdez Marine Terminal, would result in another 2,013 shipments annually (Folga et al. 2002, Table WT1).

The amount of road traffic from the pipeline termination would fall below current levels during pipeline operations. If all of the above-mentioned traffic were on Dalton Highway alone, it would represent about 20% of the current annual mileage on Dalton Highway. Thus, except for a short period of time (e.g., a few days) at a given point along the pipeline where termination activities were taking place, traffic along the highway network would be less than it is under present conditions. When termination activities were complete, the amount of traffic along Dalton Highway would be much less than the amount under current conditions.

TABLE 4.6-8 Annual Waste Shipments during Pipeline Termination Activities

Waste Type	No. of Annual Truck Shipments
Sanitary liquid waste	7,663
Noncombustible solid waste	559
Incinerator ash	108
Fiberglass	102
Polyurethane	73
Hazardous solids	2
Hazardous liquids	11
Total	8,518

Source: Folga et al. (2002, Table WT1).

4.6.2.12 Hazardous Materials and Waste Management

4.6.2.12.1 Hazardous Materials Management. Hazardous materials currently used in support of TAPS operations are present in various storage facilities at pump stations and at the Valdez Marine Terminal and off-ROW warehouses. They are also present in process equipment. Section 3.16.1 provides an overview of hazardous materials used in TAPS operations. Appendix C, Section C.2 provides detailed descriptions of hazardous material distribution throughout the TAPS. These chemicals would become superfluous once TAPS operations cease. However, many of the same chemicals used to support TAPS operations and maintenance activities would also likely be used to support the termination process. It is reasonable to expect, therefore, that existing hazardous material supplies in stock would be used to support termination activities. This is especially likely to be the case for vehicle and equipment fuels and for cleaning agents. For the chemicals in storage, adequate logistical planning against a scheduled termination event should allow the majority of existing supplies of usable hazardous materials to be depleted before termination operations cease. Amounts of hazardous materials that are not applicable to termination operations after TAPS operations cease may be recycled or transferred to other industries (perhaps through the Alaska statewide material reuse Web site) that can use these materials. Therefore, it is anticipated that no substantial waste generation would result from hazardous materials remaining in storage at the end of TAPS operations.

Substantial quantities of hazardous materials would be present in TAPS equipment at the time TAPS operations cease. It is expected that all such materials in process equipment would be removed during the cleaning and purging phase of termination and recycled. Such materials would include

Hazardous Waste Management under the No-Action Alternative

Under the no-action alternative, amounts of hazardous materials used to support TAPS operations would be reduced to zero once termination activities were completed. Hazardous waste generation could increase during the period of equipment cleanout but would be reduced to zero thereafter. Hazardous waste would be delivered to out-of-state facilities for treatment and/or disposal. Solid waste generation would increase during termination activities, primarily as the result of the increased work force and the dismantlement of TAPS facilities. Domestic solid wastes and nonhazardous solid wastes from facility dismantlement would be disposed of in APSC-owned landfills (after incineration) or in municipal landfills (after incineration in some cases). Scrap metal and other salvageable materials would be recycled at out-of-state locations to the greatest extent possible. Domestic and sanitary wastewaters would increase during termination activities primarily because of the increased work force but would then be reduced to zero as TAPS facilities were dismantled. Industrial wastewater treated at the Valdez Marine Terminal would decrease with the reduction in tanker traffic. It would then increase dramatically because of the flushing of the pipeline with seawater and surfactants during cleanout. Such wastewaters would be treated at the BWTF and discharged into the Port of Valdez pursuant to the Valdez Marine Terminal NPDES permit. Volumes of special wastes (primarily asbestos and PCBs) could increase slightly with the dismantlement of pipeline components and facilities. Some special wastes, for example, tanker garbage, would decrease with the reduction in tanker traffic at the Valdez Marine Terminal. All special wastes would be managed in accordance with existing procedures and regulations.

anhydrous ammonia recovered from heat pipes, glycol-based coolants, fire suppression agents, and some lubricants. However, brine solutions from the main line refrigeration units may have to be managed as a liquid industrial waste. Excess fuels removed from TAPS facilities as they are closed are likely to be resold in local markets. When such materials are not eligible for recycling or reuse, they would become waste streams associated with termination activities. The probability of occurrence and the impacts of those waste streams are discussed in the following sections.

4.6.2.12.2 Waste Management. On the basis of the no-action scenario described in Sections 4.2.4 and 4.6.1.1, the analysis of waste generation and management impacts is presented in two phases. The first phase addresses wastes associated with the emptying and stabilization of the TAPS, and the second phase addresses wastes directly related to system dismantlement. The generation and management of wastes during termination activities would have to comply with all applicable regulations to protect public safety, prevent environmental degradation, and minimize the risk to the environment and the public (e.g., new or modified operation permits may have to be obtained or new contingency plans developed).

It is assumed that crude oil emptied from TAPS facilities would be a potentially saleable product and would be recovered from TAPS equipment to the greatest extent possible and delivered to the Valdez Marine Terminal via the pipeline, or other means, for storage and ultimate shipment. The same is assumed for the kerosene used as the initial rinsing agent, which would also be recovered at the Valdez Marine Terminal. Wastes related to each major action, their probable character, and their most likely dispositions are discussed below. Only those actions resulting in substantial volumes of waste, wastes with hazardous characteristics, or wastes requiring special handling and disposal are included.

Unless otherwise specified, estimates of waste volumes and generation rates were derived from Folga et al. (2002).

Wastes Associated with Stoppage of Product Flow and System Cleaning.

Hazardous Wastes. At the pump stations and the Valdez Marine Terminal, cleaning of TAPS equipment and sumps, purging of transfer lines, removal of tank bottoms and scale, and removal of condensates would result in wastes. Similar wastes resulting from

TAPS operations have routinely exhibited characteristics of hazardous waste and are disposed of through a hazardous waste contractor at out-of-state Resource Conservation and Recovery Act (RCRA)-permitted TSDFs. It is assumed that the same procedures would be applied to wastes from emptying and cleaning during the termination process. Additional hazardous waste can be expected from the cleaning of ancillary fuel storage tanks. Excess hazardous materials and refined petroleum products that cannot be recycled would be characterized and, if necessary, would be managed as hazardous waste. Some discarded materials would also qualify as "listed hazardous waste" at the time a decision was made to discard them. Finally, some remediation wastes (i.e., spill debris) from responses to accidental spills of some refined petroleum products as hazardous material might also be characteristic hazardous waste. All hazardous waste would need to be transported to out-of-state RCRA-permitted treatment or disposal facilities.

Solid Wastes. Small amounts of nonhazardous industrial solid wastes would be generated as a result of emptying and cleaning TAPS equipment. The majority of the solid wastes generated during the purging and cleaning stage would be domestic wastes resulting from the increased workforce. It is assumed that these domestic wastes would be identical in character to domestic wastes generated during operations and that the management systems currently in place would continue at least through this stage. This includes the solid waste incinerators at the pump stations and the Valdez Marine Terminal, as well as portable incinerators that may be staged at pump stations or work sites during this period. It is assumed that municipal landfills and the APSC-owned landfills that currently support solid waste disposal would continue to be available.

Wastewater. During purging and cleaning of the pipeline, substantial quantities of industrial wastewater would result from flushing the system with seawater. Flushing water would be introduced at PS 1 and travel south via the pipeline to the Valdez Marine Terminal. It is assumed all such wastes would be processed at the BWTF and then discharged to Prince William Sound. The current NPDES permit for the BWTF allows treatment of raw and potable water and seawater that may contain residual products. It is expected that the seawater flushes would have an estimated average concentration of 0.02% crude oil by volume (Folga et al. 2002). The character of the seawater flushes is expected to be similar to that of the tanker ballast, which currently makes up 93% of the influent to the BWTF. Since there would be a significant reduction in the number of tanker visits to the Valdez Marine Terminal during the no-action period, the volume of ballast water being treated at the BWTF would also be reduced, thus freeing up additional capacity. Tankers are expected to visit the Valdez Marine Terminal for some period of time after oil ceases to flow in the pipeline in order to receive volumes of crude oil that are in storage at the terminal (including oil recovered in the BWTF during treatment of seawater flushes). Therefore, it is assumed that BWTF capacity would be sufficient to treat the volume of seawater used to flush the system. However, the capacity of the BWTF to accept influents is exceeded if seawater flushes arrive at a rate that is substantially higher than the rate at which ballast waters inflow to the BWTF.

The BWTF is equipped with three influent water storage tanks, each with an effective storage volume of 430,000 bbl. Maximum rates of inflow to these tanks is limited to 100,000 bbl because of their venting capacities. Peak daily flow rate through the BWTF is limited to 30 million gal/d (APSC 2000e). Therefore, the time period over which pipeline flushing will occur will be controlled by these BWTF design features. Alternatively, additional interim storage for rinsates may need to be established at the Valdez Marine Terminal. Crude oil storage tanks that have been emptied may serve this purpose.

It is estimated that a total of 399.1 million gal of seawater would be used to flush the system during termination activities; virtually all of it generated during the third year of the 6-year no-action period. Of the total volume of flushes, 2.1 million gal would have alkaline detergents and surfactants introduced to enhance cleaning capabilities. The presence of these additives can be expected to reduce the efficiency of the phase separation process at the BWTF. Therefore, a smaller percentage of crude oil would be recoverable than is normally the case during the oil water separation phase. However, it is assumed that the BWTF technology is suitable for treating the seawater flushes used to clean the pipeline, including any alkaline agents or surfactants that may be introduced, before discharge to Prince William Sound.

Finally, as discussed in Appendix C, the reconfiguration of the tanker fleet, to be completed by the year 2008, may result in changes to basic treatment technologies at the BWTF.[2] Without more information on the alternative technologies that may be implemented, it is difficult to determine what impact a new technology or configuration would have on the ability of the BWTF to process and treat flushes during the no-action period. Changes to technologies employed at the BWTF may also be appropriate for more efficient management of pipeline flushings. Although seawater flushings and ballast water have essentially the same characteristics, the differences in the mean concentrations of hydrocarbons as well as the presence of detergents and surfactants in some fraction of the flushings may argue for the introduction of alternative or complementary treatment technologies. It is reasonable to conclude that seawater flushings can be successfully treated so that the effluents discharged to Prince William Sound would meet all the specifications and discharge limits in the NPDES permit.[3]

During TAPS operations, sludge from the BWTF is characterized and disposed of in a local landfill. It is assumed that the BWTF sludge resulting from the treatment of the flushing of the pipeline would be similar in character and, therefore, similar management and disposal is expected.

Domestic wastewaters would be produced at accelerated rates by virtue of the increase in labor populations. Discharges are expected to increase at each site up to the design capacity of existing sanitary wastewater treatment facilities during periods of extensive termination field effort (see Appendix C). Secondary biological sewage treatment and effluent disposal to tundra wetlands are expected to continue for the MCCFs and PS 5 and 6. Because design capacities of the facilities are expected to reflect full occupancy of the housing facilities, the volumes of discharges from these treatment facilities would be within existing permit limits. Therefore, it is assumed that the discharges would be managed the same as during TAPS operations. However, injection of wastewater plant effluents into stacks at PS 1, 3, and 4 requires sufficient stack temperatures to ensure vaporization, volatilization, and disinfection. Elimination of turbine-powered crude-oil pumping systems would preclude the use of pump engine exhaust stacks for wastewater disposal; therefore, alternative wastewater treatment would be employed at these pump stations (e.g., package plants). The septic systems that are currently used for disposal of sanitary wastewater at PS 7, 8, 9, 10, and 12 may be inundated by volumetric increases as a result of increases to resident populations. Portable package plants may be necessary for wastewater treatment throughout the construction (dismantlement) phase of termination. Enhancement of existing sanitary treatment facilities at the Valdez Marine Terminal may be needed to accommodate increased staffing and facility use during the termination period. Leach field replacement or use of package sewage treatment plants may be necessary to accommodate termination labor crews.

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2 Some portion of the tanker fleet visiting the Valdez Marine Terminal is already of double-hulled design. Decisions and schedules for tanker reconfiguration are driven primarily by the provisions and compliance schedules in the Oil Pollution Act (OPA). However, it is possible that a no-action decision on the TAPS ROW renewal would influence the decisions and schedules of owners of tankers that visit the Port of Valdez that have not already been reconfigured to double-hulled design.

3 The permit, however, would have to be amended to address any new technologies installed and specifically include seawater flushing as an allowed influent.

Special Wastes.[4] No special wastes are anticipated as a result of the emptying and stabilization of TAPS systems.

Wastes Associated with Removal of Aboveground Facilities.

Hazardous Wastes. Very small amounts of hazardous wastes would be generated from the maintenance of vehicles and equipment used during the dismantlement and removal of aboveground facilities. It is estimated that approximately 70 yd^3 of hazardous solid wastes (e.g., mercury lamps and lead-acid batteries) and approximately 27,000 gal of liquid hazardous wastes (e.g., lubricants and solvents) would be generated from system dismantlement and the maintenance of vehicles and equipment used during the six-year termination period (Folga 2002, Table HW1). Although contractors would perform most termination activities, it is assumed that the management, transportation, and disposal of hazardous wastes would be under existing APSC management systems. Some components removed from the system may contain coatings or linings that would require characterization and possible management as hazardous waste. However, the majority of corrosion control coatings on TAPS equipment and pipeline segments are nonhazardous.

Solid Wastes. To the greatest extent feasible, nonhazardous solid wastes generated during the dismantlement of TAPS equipment and buildings would be recycled, including scrap metal and concrete. It is estimated that 105,000 tons of recovered metals annually would be recycled through Fairbanks (shipped out of either Whittier or Seward), and an additional 95,000 tons annually would be recycled through Valdez (Folga et al. 2002, Table WT1) (see Section 4.2.4.2 for a description of the management of recycled materials). Collectively, approximately 45 tons of concrete or cement building products would be recovered for reuse as fill or road base. Such materials are expected to be delivered to existing APSC or Alaska DOT material yards (Folga et al. 2002, Table WT1).

Both nonhazardous industrial wastes and domestic solid wastes would be generated during removal of aboveground facilities. The largest volumes of nonhazardous industrial wastes would result from the fiberglass insulation removed from around the pipe and from the waste polyurethane insulation removed from equipment. Fiberglass wastes are expected to be generated primarily during Years 3–5 of termination activities at an average amount of 135,800 yd^3 per year. A total of 407,000 yd^3 would result. Notwithstanding contamination from crude oil, fiberglass waste is expected to be manageable in municipal landfills. Likewise, polyurethane wastes are expected to be generated at a rate of 209,867 yd^3 per year during Years 3–5 of the termination activities, with a total amount of 629,000 yd^3 generated (Folga et al. 2002, Table NHW1). Again, notwithstanding unexpected contamination, polyurethane wastes are expected to be disposed of in municipal landfills.

Although both fiberglass and plastic wastes are eligible for disposal in APSC-owned landfills, these landfills have Class III operating permits that limit the volumes of wastes they can receive. Both the fiberglass and polyurethane waste streams would exceed the permit limitations of the APSC landfills. Therefore, these waste streams would have to be disposed of in local municipal landfills. As discussed in Section 4.3.12, during TAPS operation, solid wastes represent a minor fraction of the solid wastes received at municipal landfills (see Table 4.3-2). Although the volumes of solid wastes from routine TAPS operation delivered to municipal landfills represent only small fractions of the total waste volumes received at those sites, the ability of some of the landfills to

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4 "Special wastes" are identified in Section 3.16.5. Special wastes are those for which special handling and disposal procedures have been developed, especially in federal or state regulations. Special wastes associated with the TAPS include PCBs, asbestos, pesticide wastes, drag reducing agent, spent glycols, tanker garbage, medical waste, spent sandblast media, asphalt removed from roads or workpads, and radioactive wastes.

accommodate the substantially increased rates of solid waste generated during dismantlement is suspect. Relatively small-scale operations (e.g., Glennallen and Delta Junction) might be overwhelmed and might choose to not provide increased disposal services, because doing so might necessitate amendments to operating permits and would prematurely exhaust landfill capacity, requiring these communities to undertake the costly exercise of siting near landfills.[5] It is also important to recognize that dismantlement of the North Slope and Deadhorse facilities is also likely to generally coincide with dismantlement of the TAPS. Consequently, the Oxbow Landfill might also find it difficult to accommodate these multiple increased needs for solid waste disposal. Notwithstanding these localized logistical and capacity problems, the collective capacities of Alaska landfills located within reasonable distances of the TAPS are sufficient to meet the disposal needs that would result from TAPS dismantlement. However, all but the largest of the landfills that would choose to participate might be required to apply to ADEC for amended operating permits.

It is estimated that 57,000 yd^3 of noncombustible solid wastes (e.g., construction debris and rock cuttings generally generated during structure demolition) would be generated during the six-year termination period, with peak generation during Years 3 and 4 (25,000 and 16,000 yd^3, respectively) (Folga et al. 2002, Table NHW1). Although these wastes are eligible for disposal in APSC-owned landfills, as discussed above, permit limitations at the APSC landfills may require that these waste streams be disposed of in local municipal landfills.

Volumes of domestic solid wastes would increase substantially during the no-action period, especially during Years 3–5 because of increases in workforce populations. Incinerators currently operated at the pump stations and the Valdez Marine Terminal are assumed to continue to work to their capacities until they, themselves, are dismantled. It is expected that portable incinerators would be put into service and that nonhazardous, combustible solid wastes, primarily domestic wastes would continue to be incinerated throughout the 6-year termination period. APSC-owned landfills would continue to receive ash from the incinerators within their permit limits. The remaining ash would be delivered to municipal landfills. It is estimated that 8,100 yd^3 of incinerator ash would be generated over the entire 6-year period; the majority would be generated during the third through fifth years (Folga et al. 2002, Table NHW1). As in the past, with adequate controls, the ash should be nonhazardous.

It is reasonable to expect that the APSC-owned landfills would be used to the extent of their permits. If the APSC-owned landfills are closed, provisions in the operating permits would require the establishment of a final cover, the submittal to ADEC and execution of a revegetation plan, and filings with the State Recorder's Office encumbering the deed to prevent disturbance of the waste disposal cells by future owners. Visual inspection is required for at least five consecutive years following closure to check for signs of damage from settlement or erosion.

Wastewater. Minimal volumes of industrial wastewater would be generated during the termination process. Pipeline dismantlement would involve some excavation to remove valves at above- and belowground transition segments, and river crossings. It is assumed that any necessary dewatering activities and attendant discharges would be managed similar to those conducted during past TAPS operations under the linewide NPDES and Alaska permit. In addition, discharges would continue from containment areas and other facilities covered by the linewide NPDES and Alaska permit that remain active during some portion of the dismantlement period (e.g., existing diesel storage tanks kept active to support vehicles and equipment used during dismantlement). In addition, the EPA Multi-Sector General permit would continue to cover any industrial site discharges (e.g., material storage sites) that remain active to support dismantlement

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5 However, a permit application renewal application currently under review by ADEC for the Glennallen Landfill indicates the landfill's intention to expand service from a Class III to a Class II facility (Stockard 2002).

activities. Demolition and dismantlement activities may be governed by the EPA general permit for discharges from construction activities.

As discussed above, domestic wastewaters would be produced at accelerated rates by virtue of the intensive labor effort involved. Therefore, the design capacity of existing domestic wastewater treatment facilities may be exceeded, and alternative treatment procedures may be necessary (see wastewater section above under system cleaning). In addition, final closure of any wastewater treatment facility at the pump stations or the Valdez Marine Terminal, including septic tanks and holding tank systems, would be in compliance with ADEC approval conditions.

Special Wastes. Limited amounts of special wastes would result from system dismantlement, primarily generated at the pump stations and the Valdez Marine Terminal. Waste dielectric fluids containing PCBs would be generated when capacitors at the Valdez Marine Terminal are dismantled, since it is assumed that these capacitors are sufficiently large to require drainage prior to shipment. PCBs would also be present in capacitors removed at the North Pole metering station. Throughout the system, light ballasts removed as part of system dismantlement may contain PCBs. It is assumed that the procedures in place for managing PCBs during operations would be followed. PCB wastes would be shipped to out-of-state facilities.

Where asbestos-containing materials (ACM) are present in building components, appropriate ACM removal actions would be conducted prior to demolition. Currently, ACM removal is conducted by licensed contractors. The resulting ACM waste would be delivered to an appropriately permitted landfill (e.g., Palmer or South Cushman municipal landfills). Similar procedures would be in effect to remove ACM from TAPS equipment (e.g., pipeline gaskets) during dismantlement to ensure proper disposal. Building components containing radioactive elements (e.g., smoke detectors and self-illuminated EXIT signs) would be removed prior to demolition and managed in the same manner as during TAPS normal operations.

Ongoing remediation of contaminated media would continue in accordance with the ADEC-approved remediation plans. Management procedures for existing remediation sites, including stockpiles at three pump stations, are assumed to continue. However, additional remediation efforts necessary because of termination activities would have to have ADEC-approved remediation plans.

4.6.2.13 Human Health and Safety

This section discusses the potential consequences on human health and safety that could occur if the grant of ROW was not renewed and TAPS facilities were removed under the no-action alternative. Two types of impacts are addressed and discussed: (1) the industrial or occupational risk to workers from physical hazards and (2) the risk to the

Impacts of No-Action Alternative on Human Health and Safety

Operations, maintenance, and construction workers at any facility are subject to risks of fatalities and injuries from physical hazards. During the termination activities under the no-action alternative, the estimated annual number of fatalities for TAPS workers is less than one, while the total number of fatalities over the 6-year period is approximately one. The estimated annual numbers of recordable injuries (43–409) and lost time injuries (20–204) represent upper-bound ranges on the physical hazard risks of injuries to TAPS construction, transportation, and service workers over the 6-year period of pipeline planning and removal activities.

Criteria pollutants or hazardous air pollutants emitted from transportation vehicles used for termination activities would not cause adverse public health impacts. Health and safety impacts from a transportation-related spill were also assessed. For this spill, the maximum impact distance estimated was 0.2 km. People who remain present within this area could experience serious health effects from this or a similar spill.

general public from chemical exposures associated with termination activities.

4.6.2.13.1 Occupational Risks. At any facility, there are risks of injuries and fatalities to operations, maintenance, and construction workers from physical hazards. While such occupational hazards can be minimized when workers adhere to safety standards and use protective equipment as necessary, fatalities and injuries from on-the-job accidents can still occur. Rates of accidents have been tabulated for all types of work, and risks can be calculated on the basis of historical industrywide statistics. When possible, these statistics were used to estimate the extent of risk from physical hazards to workers under the no-action alternative.

The BLS and NSC maintain statistics on the annual number of injuries and fatalities by industry type. NSC (2000) summarizes statistics from its member companies; NSC (2001) summarizes BLS statistics. The expected annual numbers of worker fatalities and injuries for specific industry types were calculated on the basis of BLS and NSC rate data and the number of annual FTE workers that would be required for construction, transportation, and service activities during pipeline termination. In addition to the workforce required for the continuing operation of the pipeline during Years 1 and 2 (as addressed under the proposed action), it is estimated that TAPS would employ 232 workers for termination activities during Year 1, and that the number would rise to a maximum of 5,219 in Year 3, then drop to 561 by Year 6 (TAPS Owners 2001a). Since it is assumed that the general types of activities required of these employees would be similar to those carried out by employees in the construction, transportation and public utility, and industrial services sectors, those fatality and injury rates were used to estimate annual risks. Specific incidence rates for fatalities, recordable injuries (defined as total recordable cases by the Occupational Safety and Health Administration [OSHA]), and lost time injuries (defined as total lost workday cases) are included in Table 4.6-9.

Annual fatality and injury risks were calculated as the product of the appropriate incidence rate and the maximum number of FTE employees working during ROW termination: (a 2-year planning and design phase and a 4-year period for purging and cleaning of the pipeline, the actual dismantling of the pipeline, and demobilization). The annual fatality and injury estimates for construction, transportation, and service-related activities are shown in Table 4.6-9. No further distinctions among categories of workers (e.g., supervisors, laborers) were made because the available fatality and injury statistics by industry are not sufficiently refined to warrant analysis of worker rates in subcategories.

The estimated maximum annual number of fatalities for TAPS workers during pipeline termination activities would be less than one (specifically, between 0.06 and 0.60 per year). The total number of fatalities over the 6-year period would be approximately one. In contrast, incidents related to construction of the pipeline resulted in 31 lives lost, but the total work force was almost six times larger (APSC 2001i).

The estimated maximum annual number of injuries during both the planning and removal phases (i.e., the entire termination period) would range from 43 to 409 (total recordable cases) and 20 to 204 (total lost workday cases). These results are based on industrywide statistics for the construction, transportation and public utility, and services sectors from the BLS (NSC 2001). For comparison, the number of injuries was also estimated by using the incidence rate for more specific industry classifications of “heavy construction, except building,” “trucking and warehousing,” and “engineering and management services” (NSC 2000). The overall estimated maximum annual number of injuries on the basis of this subset of self-reported data from NSC member companies was somewhat lower, ranging from 13 to 190 recordable injuries and 5 to 92 lost time injuries. Therefore, the BLS-based estimated maximum annual number of recordable injuries (43–409) and lost time injuries (20–204) would be expected to represent upper bounds on the risks of injuries from physical hazards to construction, transportation,

TABLE 4.6-9 Maximum Annual Occupational Hazards Associated with Termination Activities under the No-Action Alternative

		Impacts to Workers[a]					
				Recordable Injuries[d]		Lost Workday Injuries[d]	
Phase (Time Period)	Termination Activity	FTEs[b]	Fatalities[c]	BLS	NSC	BLS	NSC
Planning (Years 1 and 2)	Demolition	415	0.06	36	11	17	4
	Transportation	0	0	0	0	0	0
	Services	138	0.002	7	2	3	1
Removal (Years 3–6)	Demolition	3,653	0.50	314	93	153	36
	Transportation	783	0.09	57	83	34	50
	Services	783	0.01	38	14	17	6

a All employees and contractors involved in pipeline termination activities were included in the physical hazard risk calculations.

b The maximum annual number of full-time equivalent workers (FTEs) for each time period were based on the assumed annual average employment for termination activities taken from the Environmental Report (TAPS Owners 2001a).

c Fatality incidence rates used in the calculations are the latest (2000) industrywide statistics from the BLS for the overall industry divisions of construction, transportation and public utilities, and services. They are 13.6, 11.5, and 1.3 fatalities, respectively, per 100,000 full-time workers (NSC 2001). Unlike injury incidence rates (see footnote d below), fatality incidence rates for more specific industry classifications, based on reports of NSC member companies, are not provided in NSC (2000).

d Injury incidence rates used in the calculations are the latest (1999) industrywide statistics from the BLS for the overall industry divisions of construction, transportation and public utilities; and services. They are, respectively, 8.6, 7.3, and 4.9 recordable injuries per 100 full-time workers, and 4.2, 4.4, and 2.2 lost time injuries per 100 full-time workers (NSC 2001). For comparison, the numbers of injuries shown in parentheses were estimated by using the latest (1999) incidence rate for more specific industry classifications of “heavy construction, except building,” trucking and warehousing,” and “engineering and management services.” They are, respectively, 2.55, 10.58, and 1.79 recordable injuries per 100 full-time workers, and 0.98, 6.43, and 0.71 lost time injuries per 100 full-time workers (NSC 2000). While this second set of NSC data may be more applicable to TAPS than the first set of BLS data, it is based on reports of NSC member companies only, so the data not be representative of termination-related industries.

and service workers over the 6-year period of termination activities.

The calculation of risks of fatality and injury from industrial accidents was based solely on historical industrywide statistics, which assume that any activity would result in some estimated risk of fatality and injury. The use of best management practices to achieve occupational health and safety compliance should reduce future fatality and injury incidence rates.

4.6.2.13.2 Risks to the Public

Risks from Pollutants in Ambient Air. During Years 1 and 2 of the termination period, the pipeline would be operating and human health risks would be the same as those discussed in Section 4.3.13. Following the 2-year planning and design phase, there would be a 3-year period during which existing facilities (i.e., the pump stations, Valdez Marine Terminal, and aboveground portions of the pipeline) would be dismantled. During this period, pollutants would be emitted from dismantling activities and operation of related transportation vehicles. After this limited period of termination activities ended, emissions from TAPS operations would stop.

The main emissions of concern for human health that would result from dismantling existing facilities would likely be criteria pollutants and some HAPs generated from the excavation activities and operation of heavy equipment. Section 4.6.2.9.1 discusses the impacts of these emissions that would be associated with no-action alternative activities. For criteria pollutants, ambient air quality standards would not be exceeded, and no adverse human health impacts would be expected. For HAPs, ambient air quality standards do not exist, but impacts to human health would be low or none because of low emission rates over a relatively short time period and releases over a large area.

Risks from Spills. Under the no-action alternative, a 3,000-bbl diesel spill scenario in the *anticipated* frequency category was assessed. The cause of the spill would be a tanker truck rollover, which could occur anywhere along the Haul Road. The methods used to assess the spill were the same as those used for assessing spills under the proposed action (see Section 4.4.4.7.2).

Because this spill volume is relatively small, only a 1-in. diesel pool depth was modeled. For this spill under maximum hazard weather conditions (F stability, 1.5-m/s wind speed), concentrations of benzene, n-heptane, and n-hexane would exceed the comparison concentrations at the edge of the spill area in the first hour after the spill, with the maximum impact distance extending to 0.2 km downwind of the spill area. Maximum concentrations of toluene and hydrogen sulfide in the first hour after the spill (330 and 31 mg/m^3, respectively) would exceed the comparison levels for mild adverse effects at the edge of the spill area, but the concentrations of both would be less than the comparison values for serious effects at the edge of the spill area. Under more typical, minimum hazard weather conditions (D stability, 3-m/s wind speed), the maximum concentrations of n-heptane and hydrogen sulfide would be less than comparison levels, the maximum concentrations of benzene and toluene would decrease to 270 and 150 mg/m^3, respectively, and the impact distance for n-hexane would decrease to 0.03 km.

Potential for Exposure to PBT Chemicals. Of the persistent, bioaccumulative, and toxic substances (see Section 3.17), only radionuclides may be associated with deconstruction activities under the no-action alternative. Naturally occurring radioactive material may be deposited in oil production pipes and vessels as the temperature and pressure of oil and water brought to the surface decreases. When equipment is taken out of production, actions are taken to avoid hazards from NORM exposure (N S Health Team Leader 2001). Although contamination with NORM is more likely to occur in equipment used at North Slope production wells, it is possible that some NORM has been deposited in TAPS equipment as well. When the pipeline is dismantled, equipment will be surveyed for the presence of NORM. If NORM is present at sufficient levels, the equipment will be segregated, secured, and properly disposed of through a licensed NORM contractor, in order to prevent exposures of workers or the general public.

4.6.2.14 Biological Resources Overview

Direct and indirect effects of the no-action alternative on biological resources are discussed in the sections that follow (through Section 4.6.2.18). The region of influence subject to direct impacts from termination activities under the no-action alternative would be the same region as that discussed for the proposed action (Section 4.3), that is, the “footprint” and vicinity of the 800-mi-long TAPS ROW and other facilities that are associated with pipeline operations. Those associated facilities include the Valdez Marine Terminal, pump stations, material sites (quarries), disposal areas, previously contaminated sites, support facilities (e.g., airports, access roads, and work camps), and the gas fuel line that supplies gas to PS 1 to 4. (These facilities are described in Section 3.1.2.1.) The region of influence subject to indirect impacts on biological resources from termination activities includes adjacent areas that would be affected secondarily by termination activities within the project footprint.

Termination activities associated with the no-action alternative that could affect biological resources include the dismantlement process, purging and cleaning of pipe and other structures left in place, generation of waste materials, regrading of project areas, revegetation activities, and accidental releases (spills) of oil or other materials. The termination process would leave certain portions of the TAPS in place (e.g., workpad, river training structures), and their continued presence would affect biological resources. In general, the no-action alternative could affect biological resources by altering habitat characteristics and the species supported by these habitats. For the most part, the short-term adverse impacts from termination activities would be followed by an eventual return to conditions more similar to those that existed before the TAPS was built. However, many Arctic region fish grow and develop slowly because of low primary and secondary productivity, short growing seasons, and low water temperature. As a consequence, recovery for fish may take longer in the Arctic region than in other areas.

Descriptions of the no-action alternative and associated impacting factors upon which the assessment of biological impacts is based are presented in Sections 4.6.1 and 4.2.4, respectively.

4.6.2.15 Terrestrial Vegetation and Wetlands

The limited field activities conducted during the first 2 years of termination under the no-action alternative would likely result in only minor impacts to terrestrial vegetation and wetlands. Otherwise, impacts are expected to be the same as those discussed for the proposed action. During Years 3 through 5, the dismantling and removal of aboveground structures under the no-action alternative would involve a variety of ground-disturbing activities; however, ground disturbance would be minimal over most of the 380 mi of buried pipe. Removal of pipe, vertical support members, valves, and other components would likely result in damage to or removal of vegetation within areas of the ROW disturbed by the operation of heavy equipment. Such disturbance might include the displacement of soil or workpad gravel and would require extensive regrading. Regrading following culvert removal and establishment of low-water crossings would also remove vegetation within the ROW in the immediate vicinity of crossings. Operation of heavy equipment might also result in soil compaction and alter soil hydrology. Activities along stream and river margins, such as the removal of bridges and abutments, would remove and disturb riparian vegetation. In permafrost areas, disturbance to vegetation might result in the development of thermokarst, which could impact adjacent vegetation communities by inundation.

Termination activities might result in disturbances to wetland areas, especially where the ROW does not presently contain a gravel pad and where wetland communities may be extensive, or areas where buried pipe adjacent to river training structures or valves would be removed. In locations where buried pipe would be removed, wetland areas might be excavated and drained during removal operations. Wetlands would not be filled under this alternative, and impacts generally would be minor and temporary. Most activities would affect previously disturbed and replanted areas of the ROW.

Up to 260 acres of land would be required for temporary storage of scrap metal (Folga et al. 2002). These storage areas would consist of previously used material sites and disposal sites, as well as available urban land. Vegetation

Impacts of No-Action Alternative on Vegetation

Under the no-action alternative, the ROW, pump station sites, and other TAPS areas would eventually become vegetated with stable terrestrial and wetland vegetative communities. These communities would have many similarities to adjacent undisturbed communities; however, differences in their structure and species composition would likely remain over the long term.

communities in these areas would already be disturbed because of previous activities. Staging areas and work camps would be located at pump stations and also would affect only previously disturbed areas.

Disturbed areas would be restored by methods currently used for restoration associated with maintenance activities (APSC 2001j). Revegetation methods and procedures for disturbed areas would require evaluation and approval by the AO and the SPC for each location. The methods used for revegetation would be modified and adjusted according to site-specific conditions. Disturbed areas would be restored as soon as practical. Restoration would have to meet performance requirements, which include the following: “remove all contaminated material; to the extent possible, return a disturbed site to its original or normal physical condition and natural biological productivity and diversity with reestablishment of native plant and animal species; prevent erosion; conform to the adjoining land forms and approximate the original land contours; maintain pipeline system integrity; remove improvements as required by the appropriate authority; and provide for public safety” (Brossia and Kerrigan 2001).

Disturbed areas would be revegetated primarily with native species occurring in adjacent natural areas. Approximately 3,151 acres of the workpad (917 acres north of MP 243, 1,128 acres between MP 244 and MP 493, and 1,106 acres south of MP 494) and 300 acres of pump station gravel pads would undergo natural revegetation. Diverse communities of local native species would develop on the restored areas. Soil compaction from the use of heavy equipment might alter soil moisture characteristics and soil structure and initially hinder the reestablishment of native species. However, revegetated areas would eventually support an effective cover of biologically diverse communities of herbaceous and woody species (McKendrick 2002).

Restoration

Restoration is “returning a disturbed site … to its original or normal physical condition and natural biological productivity and diversity by means of best practical protection, stabilization, erosion control, habitat reconstruction, and revegetation techniques with the intent of reestablishing native plant and animal species” (Brossia 2001).

Some areas, such as those that might be more susceptible to erosion or more difficult to revegetate, would be seeded with native perennial grasses (such as native varieties of red fescue and Bering hairgrass) and nonpersistent annual ryegrass, and they would be mulched if necessary. In addition, 534 acres of access road surface; 190 acres of streambanks, valve sites, and road crossings; and 350 acres at the Valdez Marine Terminal would be regraded and seeded. Extended periods of time might be required for local native species to successfully invade seeded areas and for native communities to become well established. Because native seed would be used for revegetation, the introduction of nonnative species would be limited (although nonnatives might become introduced in mulch).

Soil disturbance associated with dismantling and removal activities might result in the erosion of soil or gravel and subsequent deposition of sediment in surface waters and wetlands downgradient from the work areas. Sediments could cover plant leaf surfaces, reduce the amount of oxygen available to roots, or alter soil chemistry or soil moisture levels, thereby possibly killing vegetation or resulting in reduced growth and reproduction. The composition of the vegetative community might be altered, or vegetation might be eliminated entirely in heavily impacted areas. Excessive sediment input might reduce the capacity of wetlands to improve water quality and might cause wetland areas to convert to upland. Culvert removal, regrading, and restoration might also result in sedimentation of downstream surface water bodies; however, mitigation and monitoring would minimize the impacts. The erosion that is occasionally associated with culvert flows would be reduced or eliminated. Activities along stream and river margins, such as the removal of bridges and their abutments or buried pipe near river training structures or the regrading of workpads, might also result in sedimentation of surface waters.

Dismantling and removal activities, as well as increased vehicle traffic along the ROW and

Dalton Highway during the cleaning, purging, and removal period, would generate airborne dust. Over the 3-year cleaning and removal period, that dust would become deposited on terrestrial and wetland vegetation. However, the effects would be temporary and would not be expected to alter the composition or function of the vegetative community in the long term. Vehicle traffic associated with maintenance and monitoring activities and the transportation of workers and materials would be greatly reduced following TAPS decommissioning. Therefore, the amount of dust generated from traffic along Dalton Highway and the ROW would also likely be greatly reduced.

Accidental spills or leaks could occur during the termination period. Spills during the first two years would be similar in magnitude and frequency to those assessed under the proposed action, since pipeline operations during those years would be similar to proposed action operations. Spill scenarios evaluated for Years 3 through 5 of the no-action alternative are considered *anticipated* events (frequency greater than 0.5/yr), except for two small spills in the *likely* range (Section 4.6.1.2). Catastrophic spills are considered incredible events under this alternative and were not analyzed. The largest spill evaluated would result from the overturning of a tanker truck along the Haul Road during Year 3 (cleaning and purging stage) of pipeline termination activities. Under this scenario, 8,000 gal of kerosene would be spilled on land. A large portion of the spilled fuel would likely evaporate because of its high volatility, and impacts on land would be limited to a relatively small area (less than 0.3 acre). A portion of the fuel might enter nearby surface waters, such as wetlands. However, because of evaporation the impacts to surface water would be limited to a short distance from the spill (Section 4.6.2.6). Terrestrial vegetation and wetlands could be adversely impacted by a kerosene spill, similar to the effects of a diesel fuel spill. Vegetation in the area of the spill that came in contact with the kerosene would be killed, and recovery of vegetation would be very poor without soil remediation (Walker et al. 1978). Submerged wetland vegetation would be less affected by a spill and would likely recover.

Under the no-action alternative, control of ROW vegetation (which includes cutting woody vegetation) would cease following decommissioning, allowing native shrubs and trees to grow and increase in density within the ROW. Native species present within adjacent undisturbed communities would continue to colonize the ROW, resulting in an increase in the distribution and abundance of native species and an increased similarity between ROW communities and nearby undisturbed communities. Vegetative cover would continue to increase on most portions of the ROW that currently lack complete cover. However, the differences in substrate characteristics between the ROW and adjacent undisturbed areas might prevent the establishment within the ROW of mature communities identical to those of nearby undisturbed areas. Many impacts on vegetation associated with the initial construction of the TAPS, such as the loss or alteration of mature terrestrial and wetland communities, would continue.

Over time, vegetative communities would naturally change, as exposed areas were initially colonized by herbaceous pioneer species adapted to disturbance conditions. As the process of succession proceeded, species that are less tolerant of disturbance (often shrubs) would become established, benefiting from the conditions created by the pioneer species, which would then be expected to decline. Mature, stable communities adapted to local climatic, soil, and moisture conditions would eventually become established.

Disturbed areas within the lowland tundra portion of the ROW might initially become vegetated with grasses, such as alkaligrass (*Puccinellia* spp.) or tufted hairgrass

Differences between ROW and Surrounding Areas

Within the TAPS ROW, gravel, moisture, nutrients, organic material, and thickness of the surface organic mat differ from the surrounding undisturbed areas. The TAPS ROW generally has a high gravel content and lower moisture level, lower organic matter, and reduced organic mat thickness.

(*Deschampsia caespitosa*) (McKendrick 1999, 2002). Forbs such as dwarf fireweed (*Epilobium latifolium*) would subsequently become common. Eventually, shrubs such as willow (*Salix* spp.) would likely become dominant, along with forbs, grasses, and sedges (*Carex* spp. and *Eriophorum* spp.) (McKendrick 2002). The colonization by native shrubs would continue to increase in portions of the ROW not disturbed by dismantling and removal activities.

Disturbed areas of the upland tundra zone would follow a similar successional pattern. Polargrass (*Arctagrostis latifolia*) might initially colonize an area, with forbs such as dwarf fireweed and starwort (*Stellaria longipes*) increasing subsequently. Shrub species, including heath shrubs such as bog blueberry (*Vaccinium uliginosum*), along with willows and dryas (*Dryas* spp.), would eventually become dominant (McKendrick 2002). Native shrubs would continue to increase in areas not disturbed by dismantling and removal activities.

Herbaceous species, such as bluejoint (*Calamagrostis canadensis*) and fireweed (*Epilobium angustifolium*), would initially colonize disturbed areas in the boreal forest zone. Shrubs would subsequently become dominant and would primarily include willows and alder (*Alnus crispa*). Poplar (*Populus balsamifera*) and aspen (*Populus tremuloides*) trees would also become common components of mid-successional communities. Trees that are dominant in the adjacent mature forests, such as white spruce (*Picea glauca*) and black spruce (*Picea mariana*), would gradually colonize these areas (McKendrick 2002). Communities in the ROW presently dominated by shrub and herbaceous species in the boreal forest zone would eventually become populated with these tree species.

Pioneer Species

Pioneer plant species are adapted to soil and light conditions that often result from disturbance. They typically appear following disturbances that eliminate vegetative cover, such as avalanches or floods along rivers that create new sand and gravel bars or mud flats. Pioneer species quickly colonize these unvegetated areas and establish a vegetation cover.

Initially, disturbed areas in the coastal forest zone would also become vegetated by herbaceous species, with shrubs and broadleaf trees later becoming dominant. Trees such as Sitka spruce (*Picea sitchensis*), which are dominant in the adjacent mature forests, would gradually colonize these areas (McKendrick 2002). Communities in the ROW presently dominated by shrub and herbaceous species in the coastal forest zone would eventually become populated with these trees.

Maintenance of the workpad and pipe would cease after termination activities were completed. As long as the workpad and other disturbed areas in the ROW remained unvegetated, vegetation downgradient from the workpad or other disturbed areas might receive sediments from storm-water runoff. Erosion of the ROW from high or redirected stream flows might result in the degradation of wetlands and terrestrial communities and the potential exposure of buried sections of the pipe. Because the construction of guidebanks and revetments would cease following decommissioning, erosion of streambanks near the ROW and stream channel migration (which occasionally occurs at sharp river bends) would no longer be restricted. Materials eroded from the ROW might cover existing vegetation or be dispersed downstream, causing impacts on streamside wetlands or floodplain communities. Vegetation might be injured or killed by eroded materials, thereby reducing total vegetative cover or changing the composition of the vegetative community.

Surface water drainages crossing the ROW might become blocked by debris, such as fallen trees, or by beaver activity. Such blockages might create impoundments along the ROW, resulting in the development or alteration of wetland communities and the loss of upland communities, or they might create scouring (APSC 2001j). Inundation might also result in the

Maintenance Activities

Examples of maintenance activities that would cease include brush cutting, vegetation restoration, workpad repairs, construction of guidebanks and revetments, removal of debris from drainages, and corrosion repairs.

development and expansion of thermokarst, causing further losses of terrestrial communities.

Buried sections of the pipeline might eventually corrode, allowing the entry of groundwater into the pipe. Extensive drainage of groundwater might alter the hydrologic characteristics of wetlands, resulting in changes in the composition and function of the vegetative community. However, because groundwater levels would generally stabilize over time, such hydrologic disturbances would generally result in short-term impacts to wetlands. Corroded sections of pipe might eventually collapse and create a large, linear ground surface depression. Resulting changes in surface water drainage patterns could alter vegetative communities both within and outside the ROW, creating wetter conditions in some areas and drier conditions in others.

The continued existence of the workpad and access roads would continue to create an opportunity for human access on or adjacent to the ROW. Recreational use of the ROW might increase after aboveground structures were removed, although the growth of woody vegetation and removal of culverts would likely inhibit the extensive use of vehicles. Although the impacts resulting from human access would likely be minor, effects of vehicle use could include the injury to or destruction of vegetation, loss of vegetative communities, or changes in community structure.

4.6.2.16 Fish

In the short term, TAPS termination activities could impact fish populations and habitats in ways similar to those documented for TAPS construction (Section 3.19). Impacts to fish during Years 1 and 2 of the termination period would be similar to those described under the proposed action (Section 4.3.16) because the pipeline would continue to operate while termination activities were being planned and initiated. Removal of the aboveground portions of the pipeline would be a major construction action that would increase the number of workers and amount of vehicle movement along roadways and the workpad. In the long term, impacts on fish after completion of termination activities would likely be less than impacts from the proposed action, largely because of the decreased amount of maintenance traffic along the ROW. However, there might also be some long-term impacts associated with the deterioration of belowground pipeline components left in place.

As discussed in Section 4.3.16 for the proposed action, activities that would be most likely to affect fish would be those that would create barriers to fish movement, change water surface flow patterns, deposit sediment in surface water bodies, change water quality or temperature, contaminate water, or change human access to water bodies. The descriptions of the impacts on fish from the no-action alternative are broadly grouped into impacts that would result from (1) alteration or loss of fish habitat, (2) obstructions to fish passage, or (3) increased human access.

Impacts of No-Action Alternative on Fish

For the no-action alternative, there would be an increased potential for impacts to fish habitat during the pipeline removal phase because of increased traffic and construction activity. In the long term, impacts would be less than those from the proposed action because there would be less maintenance traffic along the pipeline ROW.

4.6.2.16.1 Alteration and Loss of Habitat. Activities related to the removal of pipeline components in the active floodplain during termination would alter fish habitat by removing vegetative cover or increasing sedimentation and erosion. During the removal of culverts and other pipeline components, there would also be the potential for increased sediment loads, alteration of instream and riparian habitat, and contamination from oil or other chemicals. Removal of cover along and within a stream could substantially reduce the carrying capacity of the altered stream reach, both by affecting the abundance and composition of some invertebrate prey and by making the area unsuitable for refuge from predators (especially terrestrial predators, such as birds and bears). Removal of stream cover could also affect the ability of some fish predators, such as northern pike, to capture prey. South of the Brooks Range, large woody debris in streams provides important cover for many fish species. Cut banks and boulders provide additional cover. North of the Brooks Range, large woody debris is less abundant, and cover is provided primarily by cut banks and boulders. Although activities in and around the active channel would likely avoid loss of these cover features, some cover would still be affected by termination activities, and localized short-term impacts on fish could occur. Although restoration of disturbed areas would include establishing vegetation and streambed contours to achieve conditions appropriate for the affected areas, the impacts on vegetative cover could persist for several years after the initial disturbance.

As during current or proposed maintenance activities (Section 4.3.16), pipeline removal operations would also need to avoid the disturbance, dewatering, or degrading of fish overwintering areas. The potential for fish mortality would increase because termination activities (e.g., culvert excavation and removal) would be required at a large number of stream crossings. As described in Section 4.6.2.6, termination activities would not be expected to affect the volume of surface water flow. However, turbidity and sediment deposition would increase if excavation occurred in streams or floodplains. Impacts on fish overwintering areas would be minimized by adhering to the current permitting process and by scheduling work to be done in streams at nonsensitive or noncritical periods for fish when possible. Fish use of affected habitat would be expected to resume once termination activities were completed. Because the pipeline components that remained buried would be cleaned before being capped, no adverse impacts would be expected from the contamination that can result when uncleaned buried pipeline components deteriorate. It is difficult to anticipate the potential long-term impacts that might occur as buried pipeline in overwintering areas would become exposed as a result of the movement of sediments and the deterioration of the remaining pipeline components. Exposure of buried pipeline components could cause changes in localized deposition or scour rates, which could result in long-term increases or decreases in the availability of overwintering areas.

The spill analysis for the no-action alternative (Section 4.6.1.2) indicates that the occurrence of a catastrophic oil spill during termination activities would be highly unlikely. Consequently, it is considered unlikely that very large volumes of oil would be introduced into waterways as a result of termination activities. The most damaging spill presented in the spill analysis for the no-action alternative was associated with an accident involving the rollover of a tanker truck transporting diesel fuel for use by heavy equipment during the purging and cleaning stage of termination. It is estimated that one or two such accidents might occur during the termination period and that up to 3,000 gal of diesel fuel or 8,000 gal of kerosene could be released. The potential impacts on fish from such a release would depend on how much of the spilled fuel entered a stream, the size of the stream, the species of fish present, and the timing of the spill relative to the life cycles of those species. Although such a spill could lead to mortality of fish in a particular stream segment, it is anticipated that (1) the effects would not persist for more than a few days because of the volatilization of the diesel fuel or kerosene from the water’s surface and dilution by mixing with the water and (2) the fish community would recover. Other spills of diesel fuel or kerosene considered in the spill analysis (Section 4.6.1.2) were of smaller volume (20 to 250 gal) and could occur several times a year. However, it is anticipated that the effects of such spills would be relatively minor compared with the 3,000- to 8,000-gal spill scenarios discussed above even if the spill reached fish streams.

As discussed in Section 4.3.16, increased levels of turbidity and sedimentation could adversely affect fish populations. Under the no-action alternative, termination activities such as removing culverts, regrading stream crossings, and excavating pipeline components located near water bodies could increase the amounts of sediment in nearby water bodies. Removal of pipeline components during termination activities would be regulated by (1) the linewide NPDES permit; (2) the Wastewater General Permit; (3) the NPDES Permit for Storm Water Discharge from

Construction Activities Associated with Industrial Activity, as discussed in Section 3.7.2.5 (Surface Water Quality along the ROW); and (4) fish habitat permits. In addition, as is typical practice, construction activities would be avoided during winter months in areas where overwintering fish might be affected (Section 4.3.16). As long as termination activities complied with stipulations of those permits, impacts on fish from removal activities would be expected to be minor and temporary.

Under the no-action alternative, discharges into Prince William Sound from the BWTF and the sanitary water treatment plant at the Valdez Marine Terminal would eventually cease. Since discharges from both of those facilities currently are in compliance with permit requirements (Section 4.3.8.1), no measurable difference in impacts on fish in Prince William Sound is anticipated from the no-action alternative compared with the proposed action.

4.6.2.16.2 Obstruction of Fish Passage. The potential for blockage of fish passage would increase as culverts were removed. Barriers to fish movement might be created during removal of culverts and by increased traffic across low-water crossings. Increased traffic could lead to severe rutting of streambeds, which could, in turn, create ridges and spread flow, thus causing barriers to fish movement at low flows. Low-water crossings would need more frequent maintenance during the removal period to ensure that fish passage was maintained. The removal of culverts and road casings would need to be planned and monitored to ensure that proper erosion control methods were used and that the contour of regraded streambed crossings was consistent with the natural topography. Impacts associated with fish passage obstructions — such as migrating fish being unable to move to spawning, feeding, or overwintering areas — could be reduced by not scheduling termination activities during sensitive times for fish (Table 3.19-2).

Activities that could obstruct fish movements would continue to be reviewed under the ADF&G Title 16 and fish habitat permit processes as termination activities occurred. As would occur under the proposed action, effective use of these review processes during removal activities would likely minimize obstructions to fish movement along the TAPS ROW (SPCO 1993, 1995), and only minor impacts on fish would be anticipated. After removal of pipeline components and regrading of stream crossings to reflect natural contours, the rates at which blockages to fish passage would occur at the former stream crossing areas would, in most cases, probably be similar to natural rates of fish blockage. An exception would be in spots where buried pipeline that crossed a stream remained in place. In some cases, deterioration of the buried pipeline, followed by the subsidence of overlying substrate or the exposure of buried pipeline components through sediment scouring, could result in long-term impacts on fish passage as the contour of the stream segment was altered.

Although exposure of buried pipe periodically occurs now and would also occur under the proposed action, ongoing surveillance programs identify problems, and corrective actions are taken. Under the no-action alternative, it is assumed that surveillance activities would be discontinued once termination was completed; however, the level of surveillance following termination would be determined by the Authorized Officer at the time of termination. Approximately 210 belowground pipeline stream crossings occur along the TAPS ROW (Table 3.19-2). Seventy-four of these crossings occur in anadromous fish streams, where maintenance of fish passage is considered especially important. Thus, deterioration and exposure of belowground pipe could possibly affect about 68% of the crossings of anadromous fish streams (i.e., 74 of 109 designated anadromous fish stream crossings). If even a small proportion of these stream crossings became impassable to migrating fish for an extended period, these could be a substantial impact on anadromous fish populations in the affected streams and an adverse impact on essential fish habitat. The potential would also exist for adverse effects on the resident populations of some fish species in nonanadromous fish streams if movement between overwintering and spawning or feeding areas was prevented. Of the 210 belowground crossings, the number that would become impassable to fish is unknown. Probably only a small percentage would be affected; however, loss of fish passage in even some of these streams could have a measurable impact on fish populations.

Minor incidences of entrapment due to the attraction of fish to water heated by the pipeline would cease under the no-action alternative because warm oil would no longer be flowing through any remaining buried sections of pipe. The small numbers of fish currently lost in streams where instream pipeline burial causes such temperature problems (e.g., the Atigun, North Fork Chandalar, Dietrich, and Middle Fork Koyukuk Rivers, as discussed in Section 4.3.16) would no longer be affected.

4.6.2.16.3 Human Access.

Overharvest would probably not be a concern during termination, since termination activities would be of relatively short duration and would not create new access. However, fishing pressure by workers during the expected 3 years of peak activity might be heavy in some localized areas. After TAPS operations ceased and termination activities were complete, the increased harvests from a variety of sources (i.e., legal, illegal, sport, subsistence, and commercial) could have a potentially important impact on fish. The termination of TAPS would likely be accompanied by significant reductions in statewide employment and incomes (Section 4.6.2.19). If residents used wild foods to compensate for the loss of income, this impact could increase pressure on fish (e.g., through sport, commercial, and subsistence fishing). If decreased state revenues also resulted in less enforcement of fish regulations, this pressure could be intensified. It is also possible that the human population (and fish harvests) would decrease in response to the anticipated economic decline. Removal of some bridges and water crossings would probably reduce access through time, thereby reducing the harvest of fish in some areas.

Human Access

A small temporary increase in impacts to fish might result from increased human access to fishing areas during TAPS removal activities.

4.6.2.17 Birds and Terrestrial Mammals

The potential effects of the no-action alternative on wildlife can be grouped into five general categories: (1) habitat loss, alteration, or enhancement; (2) disturbance and/or displacement; (3) mortality; (4) obstructions to movement; and (5) spills. The magnitude of the impacts on wildlife from termination activities could approach the level that occurred during TAPS construction. For this discussion, “termination activities” pertain to Phases 2–4 that would be conducted following the end of the current grant termination in 2004 (Table 4.6-1). Impacts during Phase 1 would be the same as those discussed for the proposed action. Adverse impacts from termination activities would be minimized through JPO oversight, adherence to federal and state laws and regulations, adherence to the Environmental Management System Compliance Manual (APSC 2000b), and resource agency monitoring.

Impacts of No-Action Alternative on Birds and Terrestrial Mammals

Adverse impacts to birds and terrestrial mammals from the no-action alternative would primarily occur during the period of termination activities. Impacts would be similar to those that occurred during TAPS construction. Termination activities at the aboveground segments of the pipeline system would have the higher level of impacts because of the more intensive activities and longer time required to dismantle and dispose of the pipeline components. Following termination activities, the pipeline corridor would be restored to habitat conditions comparable to surrounding areas. Achieving this level of restoration could take several years to several decades. No direct population-level adverse impacts to any species would be expected from the no-action alternative. Indirect adverse impacts could potentially occur from adverse socioeconomic impacts associated with the no-action alternative (e.g., increased wildlife loss from subsistence hunting).

This adherence would involve complying with regulations, restricting hunting by employees, protecting habitats within zones of restricted activity, and training employees about wildlife concerns.

4.6.2.17.1 Habitat Loss, Alteration, or Enhancement. During termination activities, habitat alteration would result from (1) ground disturbance, such as VSM and aboveground pipe removal and other earthwork during termination activities, (2) dust fallout along Dalton Highway from increased traffic associated with termination activities, and (3) waste discharges and accidental oil and fuel spills. Habitat along the ROW would be disturbed during the removal of the aboveground sections of the pipeline and the regrading of the workpad. Temporary habitat loss would also result from the regrading of access roads and stream banks (Folga et al. 2002, Table DL1). However, the impacts of termination activities on habitat would be less than what occurred during TAPS construction, because the buried portions of the pipeline would not be removed.

Areas where the aboveground structures would be removed and the workpad would be regraded would have the greatest potential for impact. Such areas would occur in several wildlife habitat concentration areas (Table 4.6-10). Wildlife would avoid portions of the ROW and adjacent areas where termination activities would be taking place. These habitat losses would be short term. To the extent practicable, pipeline removal and workpad regrading would be conducted during periods when wildlife habitat concentration areas were not being used.

The TAPS ROW and associated facilities have enhanced the habitats of several bird species (e.g., gyrfalcons, common ravens, swallows, snow buntings) by providing structures for nests, perching, and resting (Section 3.20.1). With the removal of the aboveground sections of the pipeline and dismantling of facilities during termination activities, those artificial nesting structures would be eliminated, reducing nesting opportunities for these species (TAPS Owners 2001a).

Cessation of vegetation control along the TAPS ROW would allow natural succession and the eventual return toward the vegetation found in surrounding areas (Section 4.6.2.15). However, it might take more than 20 years for signs of the pipeline ROW to disappear in some areas (TAPS Owners 2001a). Revegetation of sloped areas with grasses might create grazing areas for Dall sheep, caribou, and geese that would last until the palatability of the grass diminished (about 5 to 10 years). Growth of browse, which is currently limited on the workpad by regular mowing, would increase food resources or habitat for wildlife such as moose and hares (TAPS Owners 2001a).

The loss or alteration of some important habitat or use areas could result from termination activities. Calving areas and mineral licks have been identified as critical areas for caribou, Dall sheep, moose, and bison along the TAPS ROW. Many of these sensitive habitats have been protected by implementing BLM-designated ACECs (BLM 1989). Activities in all identified sensitive habitats for terrestrial mammals in the vicinity of TAPS are regulated by federal and state mitigation stipulations, which are in place to minimize adverse impacts on wildlife. If all stipulations and mitigation measures currently in place were to continue, as expected, during active termination activities, the no-action alternative would not adversely affect these important habitats.

The effect of termination activities on the occurrence of impoundments is difficult to predict. Gravel pads would remain in place and cause some snow drifts and water impoundments along the workpad. Persistent snow drifts or impoundments would reduce habitat availability during early summer and could reduce breeding near roads and pads. Planned removal of culverts along access roads would help restore natural cross drainage and prevent impoundment. Culvert removal would result in species-specific adverse or beneficial impacts, depending on the species and the conditions that developed following culvert removal. Impacts of water impoundments on wildlife are discussed in Section 4.3.17.

TABLE 4.6-10 Estimated Sizes of Areas in Which the Aboveground Pipeline and Associated Workpad Are Located in Important Wildlife Habitats

	Area of Aboveground Pipeline and Workpad (acres)		
Type of Wildlife Habitat Concentration Area[a]	Northern Section (MP 0 to 243)	Central Section (MP 244 to 493)	Southern Section (MP 494 to 800)
Waterfowl nesting	22	–[b]	–
Waterfowl spring seasonal use	15	–	–
Waterfowl migration route	–	–	44
Trumpeter swan nesting and brooding	–	–	307
Sharp-tailed grouse display area	–	–	29
Bison movement area	–	–	73
Bison calving area	–	–	51
Black bear use	–	66	–
Brown bear spring and berry use	307	22	–
Caribou winter use	88	–	219
Caribou migration	416	–	–
Caribou movement	15	–	–
Caribou calving	88	–	80
Moose winter	161	321	328
Moose rutting	–	22	–
Moose calving	–	44	117
Total area within pipeline/ workpad section[c]	1,106	1,128	917

[a] Habitat concentration areas may overlap (e.g., caribou and moose concentration areas).

[b] A dash indicates that there is no aboveground pipeline or workpad in these areas.

[c] Column entries do not add to totals because of overlap of habitat areas.

Source: APSC (1993) and references cited therein and Folga et al. (2002, Table DL1).

Impacts on wildlife from dust fallout along unpaved roads (e.g., earlier occurrences and higher densities due to early vegetation green-up) are discussed in Section 4.3.17. The magnitude of dust fallout could increase during termination activities because of the higher traffic volume. This increase might benefit wildlife during the years required to remove the pipeline along the Dalton Highway.

After termination activities, traffic levels on the Dalton Highway would likely decline substantially, particularly during winter, reducing dust fallout and the correspondingly advanced (up to 2 weeks early) snowmelt in the dust shadow adjacent to roads and pads. The loss of the spring dust shadow and its associated open water and tundra would affect the distribution and movement of birds along the road. Without the dust shadow and its snow-free habitats, birds flying north through the TAPS region in spring would move in a more natural pattern, following naturally occurring snow-free zones along the Sagavanirktok River and Franklin Bluffs (TAPS Owners 2001a).

4.6.2.17.2 Disturbance and/or Displacement. Equipment noise, vehicles, pedestrians, aircraft operations, and other activities associated with termination activities would disturb wildlife. Roads could alter animal behavior by causing changes in home range, movement, reproductive success, escape response, stress, and other and physiological states; roads could also increase passive harassment as a result of increased human presence (Trombulak and Frissell 2000). In general, the level of disturbance to waterfowl increases as the traffic rate increases; as the number of large, noisy vehicles increases; and as the birds' distance from locations of disturbance (such as the Dalton Highway and pump stations) decreases (Murphy and Anderson 1993). Traffic as infrequent as one trip per 1.5 days can cause individuals to avoid an area up to 0.6 mi from the road. However, since most species are dispersed over a large area, no population-level effects would be expected (BLM 1998).

Generally, wildlife disturbance would be greater during termination activities than during normal operations. However, Phases 2–4 of the termination activities, as discussed in this section, would last for a total period of only 4 years, and localized areas of the TAPS ROW would be disturbed for only a short period of time. For example, more than 2 mi of the workpad could be regraded within 1 day (Folga et al. 2002, Table DL1). The sensitivity of wildlife to disturbance depends on a number of factors; the season in which the disturbance occurs can be especially important if it relates to a critical life history stage (e.g., calving, denning, or nesting). For example, brown bears are less sensitive to disturbance from mid-November to the end of April (during denning), caribou are less sensitive from November to mid-March (during winter range occupancy), and waterfowl and shorebirds are less sensitive from October to mid-May (when they are generally not in the area). However, other species, such as muskox, are sensitive to disturbance year-round (ACS 1999). Table 4.6-10 lists important wildlife habitats within which aboveground portions of the TAPS are located. Scheduling of pipeline removal during winter or other less critical periods would minimize disturbance, particularly to migratory birds. After termination activities, localized improvements in these habitats would occur when vegetation was established within the workpad area.

Additional disturbance would probably result from the increase in the work force during termination activities. Wildlife near areas of termination activities could be harassed by humans. These impacts could be mitigated by compliance with lease stipulations. The number of humans on foot around pump stations would be greater during termination activities than during normal operations. Restricting foot traffic to gravel pads would minimize disturbance to wildlife that were using adjacent habitats.

Aircraft activity would occur at irregular intervals during termination activities, presumably less often than the weekly flights that would occur during the continued operation and maintenance of the TAPS under the proposed action (TAPS Owners 2001a). In general, flight restrictions that would limit low-flying aircraft during the more sensitive periods for birds (e.g., nesting and brood-rearing periods) could minimize the magnitude of impacts. Aircraft disturbance associated with the no-action alternative would not likely affect terrestrial mammal populations in the vicinity of the TAPS ROW, assuming that flights followed the stipulations of the *Environmental Management System Compliance Manual* (APSC 2000b).

Noise associated with termination activities could disturb wildlife in the habitats adjacent to facilities being removed. Because facilities along the TAPS have operated for more than 20 years, it is likely that some wildlife have become habituated to the constant sources of noise, but the activities associated with termination activities would increase noise levels. However, unlike during the proposed action, when facility noise could cause wildlife to reduce their use of areas being constantly disturbed for a long time, during Phases 2–4 of the termination activities, the associated displacement of wildlife would last for a relatively shorter time (4 years or less for all termination activities), and noise sources would be eliminated once facilities were removed. After termination activities, habitats that had been avoided by wildlife during pipeline operation because of the close proximity of facilities and humans (e.g., the pump stations and Valdez Marine Terminal) would be reinhabited.

During termination activities, animal feeding and nuisance animal issues might become problematic because of the presence of an increased number of workers who might have less training in the environmental aspects of the project and have a shorter-term view of the consequences of their actions. Problem animals (e.g., bears and wolves) might have to be deliberately displaced to protect lives and property, either through harassment or live-trapping and releasing. However, continued enforcement of the APSC policy on garbage management and intentional animal feeding, in addition to the education of workers on the adverse effects of feeding wildlife, should prevent this problem from reaching important levels (APSC 2000b). Beavers could continue to cause flooding and would need to be trapped and moved as long as drainage patterns through culverts were maintained (TAPS Owners 2001a).

After termination activities, the workpad would provide attractive camp sites for tourists, hunters, and other recreationists. In addition, the use of the TAPS ROW as a travel corridor for snow machines and all-terrain vehicles could increase substantially with the end of access restrictions. Wildlife would be disturbed by these uses, particularly by vehicles.

4.6.2.17.3 Mortality. With the removal of the aboveground sections of the pipeline and pump station facilities, the potential for birds to collide with these structures would be eliminated. However, increased traffic levels during termination activities would probably result in increased roadkills, especially in the northern portion of the ROW, where the effect of the dust shadow is more prominent. As previously mentioned, wildlife concentrate near unpaved highways during spring snowmelt, and increased roadkills are observed during that period. Ptarmigan, grouse, and passerines are the primary species groups of birds that are killed by vehicle collisions. Raptors (e.g., rough-legged hawks and short-eared owls) have not often been identified as collision victims along the Dalton Highway, especially in the northern portion. Big game species are also killed by vehicles. Each year, about 760 moose and 50 Sitka black-tailed deer throughout Alaska die as a result of collisions. The vast majority of these roadkills do not occur near the TAPS or the North Slope (Cronin 2002). Six or fewer roadkills per species are reported annually throughout the state for caribou, bison, Dall sheep, bears, and wolves (TAPS Owners 2001a). The small mammals and furbearers that are most likely to be struck by vehicles include foxes, ground squirrels, and porcupines (TAPS Owners 2001a). After completion of termination activities, traffic along the Dalton Highway would be reduced from current levels, although public use for recreation and tourism would likely increase (BLM 1998; Jeffrey 1993). Thus, some roadkills could be expected after termination activities.

As previously mentioned, predators and scavengers could be attracted by food and garbage or by handouts in areas of human activity. In some instances, control measures might include shooting the offending animals. This solution occurred during pipeline construction, has continued at a low level during the operational lifetime of the TAPS, and could be expected to be required during termination activities.

The increased work force associated with active termination activities might increase hunting pressure on terrestrial mammals in the vicinity of the ROW and across the state. However, the *Environmental Management System Compliance Manual* (APSC 2000b) restricts hunting by employees. Changes in the harvest of game bird species near the TAPS ROW have not been well-documented, but access by hunters has increased along the route since construction. After termination activities, with the opening of the entire ROW, the level of harvest would be expected to increase further, particularly by hunters previously deterred by APSC's requirements for accessing the ROW (TAPS Owners 2001a). After termination activities were complete, a potentially important impact on birds would be increased harvests from a variety of sources (i.e., legal, illegal, sport, and subsistence). The termination of TAPS would be accompanied by significant reductions in statewide employment and income (see Section 4.6.2.19). If residents used wild foods to compensate for the loss of income, sport and subsistence hunting might increase pressure on birds. If decreased state revenue resulted in less enforcement of game regulations, this pressure could be intensified. However, it is also possible that the human population (and bird harvests) would decrease in response to the economic decline. Regulation and monitoring by the appropriate agencies would be needed to manage this potential impact (TAPS Owners 2001a).

4.6.2.17.4 Obstructions to Movements. During termination activities, localized obstruction of wildlife movement across the TAPS ROW could occur in the areas where the pipeline was being dismantled. The presence of humans and machinery and the stockpiling of pipeline and other scrap materials could impede wildlife movement. In addition, the volume of traffic along Dalton Highway could be greater in areas undergoing dismantlement. This traffic would limit the ability of some brood-rearing waterfowl to cross the road. Higher traffic volumes (usually more than 10 vehicles per hour) and larger, heavier, and unusual-profile vehicles (e.g., boom cranes) would disturb brood-rearing waterfowl more than would lower traffic volumes and lighter-weight vehicles (Burgess and Ritchie 1987, 1990, 1991; Murphy and Anderson 1993). Removal of the pipeline and regrading of the workpad during winter would minimize impacts, since few birds are present then.

As addressed in Section 4.3.17, the combination of pipelines and roads could obstruct or delay movements of female caribou with calves. This impact could be mitigated by restricting traffic volumes during the calving period (mid-May to early June). While aboveground sections of pipeline were being dismantled, care would need to be taken to avoid piling pipes on the ground in areas known to be regularly used by terrestrial mammals for movement. Morgantini (1985) reported that pipe acted as a visual and physical barrier to the free movement of moose and deer.

Removal of aboveground sections of pipe would ensure free passage of terrestrial mammals after termination activities were completed. Furthermore, revegetation would increase habitat diversity. Traffic levels along the Dalton Highway would also decrease dramatically (Section 4.6.2.11). Roads and other corridors that received little human use might be attractive to wolves and other wildlife as easy travel routes (James and Stuart-Smith 2000). Thus, following termination activities, wildlife use of the workpad, access roads, and, to a lesser extent, Dalton Highway might increase.

4.6.2.17.5 Spills. During the period that the pipeline is purged of remaining oil, small-volume oil spills could occur. A large oil spill would be extremely unlikely. Once the pipeline was flushed of oil prior to dismantlement, there would presumably not be any further potential for a crude oil spill. The minimal impacts on wildlife from a small oil spill and from subsequent cleanup activities during the early period of termination activities would be similar to the impacts discussed for a small spill in Section 4.4.4.11. During termination activities, some fuel (e.g., diesel) and chemical spills could occur, but they would generally be confined to gravel roads and facilities. The probability that terrestrial mammals would be exposed to such spills would be small and limited to a few individuals. After termination activities were complete, there would be no oil, fuel, or chemical spills associated with the TAPS.

4.6.2.18 Threatened, Endangered, and Protected Species

Six species listed under the ESA as threatened or endangered or under the MMPA as depleted occur in the vicinity of the TAPS and could be affected by the no-action alternative and associated termination activities. These six species are the same as those that could be affected by the proposed action (see Section 4.3.18) and include spectacled eider, Steller's eider, fin whale, humpback whale, beluga whale, and Steller sea lion. Anticipated impacts to these species are described in this section and summarized in Table 4.6-11. The impacts on other protected marine mammals and State-listed species are also presented in Table 4.6-11. None of the listed and protected species that occur within the Beaufort Sea would be affected by termination activities because these activities are not expected to affect the waters of the Beaufort Sea. Following termination activities, an increase in harvest of

TABLE 4.6-11 Potential Impacts of the No-Action Alternative on Threatened, Endangered, and Protected Species

Species	Status[a]	Time of Year	Locations	Potential Impacts
Spectacled eider	ESA-T AK-SC	May–Sept.	Wetlands and ponds of coastal plain (MP 0–40)	Increased impacts could result from disturbance in the immediate vicinity of the ROW during the termination process. Erosion of work areas could affect adjacent eider habitat until a vegetation cover became established. After completion of termination activities, decreased human activity and cessation of facility operation would reduce impacts on the species.
Steller's eider	ESA-T AK-SC	May–Sept. along ROW; winter in Prince William Sound	Wetlands and ponds of coastal plain (MP 0–40); Prince William Sound	Same as above along the ROW. In Prince William Sound, very slight potential benefit may result from eliminating effluent discharge from the Valdez Marine Terminal, but current operations already are thought to have little or no effect on this species.
Eskimo curlew	ESA-E AK-E	NA	NA	No impacts are anticipated because the species is probably extinct. It previously nested in arctic tundra of Alaska and Canada.
American peregrine falcon	ESA-DM AK-SC	April–Sept.	Near rivers and lakes south of Brooks Range (MP 240–800)	Disturbance in the immediate vicinity of the ROW could result from noise and human activity associated with termination activities. Removal of facilities and restoration of the ROW would eliminate adverse impacts.
Arctic peregrine falcon	ESA-DM AK-SC	April–Oct.	Near Sagavanirktok River (MP 0–110)	Same as above.
Olive-sided flycatcher	AK-SC	April–Oct.	Coniferous forest south of Brooks Range (MP 240–800)	Same as above.
Gray-cheeked thrush	AK-SC	May–Oct.	Coniferous and mixed forest south of Brooks Range (MP 240–800)	Same as above.
Townsend's warbler	AK-SC	April–Oct.	Coniferous forest in Yukon River valley (MP 330–380) and southern Alaska (MP 540–800)	Same as above.

TABLE 4.6-11 (Cont.)

Species	Status[a]	Time of Year	Locations	Potential Impacts
Blackpoll warbler	AK-SC	April–Oct.	Coniferous and mixed forest south of Brooks Range (MP 240–800)	Same as above.
Gray whale	ESA-D MMPA-P	Late spring and early fall	Prince William Sound	Very slight potential benefit could result from eliminating effluent discharges from the Valdez Marine Terminal to Prince William Sound, but current operations already are thought to have little or no effect on this species.
Fin whale	ESA-E MMPA-D	April–June	Prince William Sound	Same as above.
Beluga whale	MMPA-D	Winter	Prince William Sound	Same as above.
Minke whale	MMPA-P	Summer	Prince William Sound	Same as above.
Humpback whale	ESA-E MMPA-D AK-E	Summer	Prince William Sound	Same as above.
Killer whale	MMPA-P	All year	Prince William Sound	Same as above.
Pacific white-sided dolphin	MMPA-P	All year	Prince William Sound	Same as above.
Harbor porpoise	MMPA-P	All year	Prince William Sound	Same as above.
Dall's porpoise	MMPA-P	All year	Prince William Sound	Same as above.
Steller sea lion	ESA-E MMPA-D AK-SC	All year	Prince William Sound	Same as above.
Harbor seal	MMPA-P	All year	Prince William Sound	Same as above.
Sea otter	MMPA-P	All year	Prince William Sound	Same as above.

[a] Notation: ESA = listed under the Endangered Species Act with the following qualifiers: E = endangered, T = threatened, D = delisted, DM = delisted but being monitored, AK-SC = Alaska species of special concern. MMPA = listed under the Marine Mammal Protection Act, with the following qualifiers: D = depleted, P = protected. NA = not applicable.

Impacts of No-Action Alternative on Threatened, Endangered, and Protected Species

Under the no-action alternative, impacts on listed and protected species would result from ground-disturbing activities, equipment noise, and human disturbance during termination activities. These impacts would be greater than those of the proposed action for the duration of the termination process but would decrease to less than those of the proposed action as operations ceased, natural succession occurred in previously disturbed areas, and the effects of past development diminished. Impacts would not be expected to produce population-level effects that are distinguishable from natural variation in numbers.

threatened, endangered, and protected species might occur because of increased economic reasons to pursue subsistence (see Section 4.6.2.20). However, increased harvests of protected species are expected to be negligible (i.e., would not be expected to produce population-level effects).

4.6.2.18.1 Impacts on Spectacled and Steller's Eider. Impacts of termination activities on the spectacled and Steller's eider would be qualitatively similar to those of the proposed action (see Section 4.3.18). Overall, the potential for interaction between these species and termination activities is relatively low because of the distribution and density of the eider populations in the project area. Although termination activities would temporarily increase human activity along the TAPS ROW on the North Slope where eiders occur, these impacts would eventually lessen as operations ceased, natural succession occurred on the ROW, and the effects of past development diminished (see Section 4.6.2.15).

Human activities associated with termination activities would occur along the ROW for a period of up to 4 years (Years 3-6). These activities would include dismantling of aboveground facilities, excavation of VSMs, culvert removal, regrading, extraction and transport of gravel and other materials, and revegetation. These actions and the noise generated by equipment operation could disturb eiders, especially during the nesting period.

Sensitivity of the spectacled eider and Steller's eider to disturbance would vary according to season. Eiders are attracted to North Slope impoundments during the pre-nesting and brood-rearing period but not during nesting (Warnock and Troy 1992). Increased human activity along the ROW during termination activities could increase disturbance to eiders and cause them to avoid the ROW area if those activities occurred during the spring, summer, or fall. However, subsequent decreases in the level of termination activities and the eventual cessation of facility operations (including pump stations and other facilities) could cause eiders to return to previously avoided areas.

Under the no-action alternative, ground-disturbing termination activities could affect spectacled and Steller's eiders in the vicinity of the TAPS by affecting their habitats. Most of these activities would be limited to the existing workpad and facility sites; however, runoff from construction areas could affect adjacent habitats. Spectacled eiders use roadside impoundments (like those that occur near the TAPS) during the pre-nesting and brood-rearing periods (Warnock and Troy 1992). Any degradation of these habitats caused by sedimentation or runoff could have an adverse impact on eiders. Erosion control practices identified in the *Trans-Alaska Pipeline Maintenance and Repair Manual* (APSC 2001j) and subject to the approval of the Joint Pipeline Office would minimize sedimentation effects during termination activities. Regrading, slope stabilization, and revegetation would greatly reduce these impacts, and natural successional processes would eventually eliminate the adverse impacts from termination activities.

4.6.2.18.2 Impacts on Fin Whale, Humpback Whale, Beluga Whale, and Steller Sea Lion. The fin, humpback, and beluga whale and Steller sea lion all occur in

Prince William Sound at various times of the year. These species could be affected by normal operations under the proposed action if effluent discharged from the Valdez Marine Terminal BWTF and sanitary wastewater treatment plant into Prince William Sound degraded the water quality. The no-action alternative would eliminate these discharges once termination activities are complete and could potentially benefit species in the Sound, but current operations already are thought to have little or no effect on these species.

4.6.2.18.3 Impacts on Other Species. A number of other protected species or species of concern exist along the TAPS ROW or in Prince William Sound (Table 4.6-11). The American peregrine falcon, Arctic peregrine falcon, olive-sided flycatcher, gray-cheeked thrush, Townsend's warbler, and blackpoll warbler occur in various habitats and locations along the TAPS ROW and could be disturbed by termination activities associated with the no-action alternative. For the most part, these disturbances would be expected to only temporarily displace individuals until project activities ceased after the 6-year period of termination activities. Once TAPS operations ceased, facility noise and activities would be eliminated, and adjacent habitats that had been avoided by these species could be reoccupied.

Several species of protected marine mammals occur in Prince William Sound (gray whale, minke whale, killer whale, Pacific white-sided dolphin, harbor porpoise, Dall's porpoise, harbor seal, and sea otter). None of these species is considered rare or is listed as depleted under the Marine Mammal Protection Act (MMPA). Impacts of the proposed action could occur if discharges from Valdez Marine Terminal facilities degraded water quality in Prince William Sound. Elimination of these discharges once termination activities are complete under the no-action alternative could potentially benefit species in the Sound, but current operations already are thought to have little or no effect on these species.

4.6.2.18.4 Spills. During Years 1 and 2 of the termination activity period, oil would continue to flow through the pipeline, and the potential for an oil spill would be the same as that described under the proposed action. During purging and cleaning of the pipeline in Year 3, the potential volume of oil spills would decrease. Spills that might occur would be small and localized. Therefore, impacts to threatened, endangered, and protected species would be negligible to none (on the basis of potential effects from small spills assessed in Section 4.4.4.12). Also during termination activities, some fuel (e.g., diesel) and chemical spills could occur, but they would generally be confined to gravel roads and TAPS facilities. The probability that threatened, endangered, and protected species would be exposed to such spills would be negligible as well. Following termination activities, no spills associated with the TAPS would occur.

4.6.2.19 Economics

The analysis of the no-action alternative considers both direct and indirect impacts from pipeline termination activities and from lost pipeline operation, lost oil production, and associated changes in transportation over the period 2004 to 2034 on the economy of the nation, state, and pipeline corridor region. Appendix A, Section A.8 describes the methodology used to calculate these impacts. The impacts of pipeline removal and lost oil

Impacts of No-Action Alternative on Population, Gross State Product, Employment, and Income

Population in the state would continue to grow under the no-action alternative, with fairly rapid growth expected in the Alaska Native population. While there would be a substantial drop in gross state product following the end of oil production in 2003 even with the continuation of termination activities through 2007, the impact of not renewing the Federal Grant on employment, unemployment, and personal income in the state would be smaller. While growth would be expected in each of these measures over the period 2004 to 2034, especially during the second half of that period, economic activity in the state would still be far below the levels in 2003.

production on Alaska Native corporations and subsistence activities are also considered.

4.6.2.19.1 Assumptions Used in the Analysis. Various assumptions were made in order to conduct the analysis, including assumptions about the pipeline termination itself and about other activities in the Alaska economy — in particular, activities in key sectors that are important sources of potential future employment: seafood, tourism, air cargo, and state and local government.

Assumptions about Pipeline Operation and Termination. Termination assumptions are as follows:

- *North Slope oil production*. No North Slope oil production would occur beyond the end of 2003, and the last crude oil would flow through the TAPS at the beginning of 2004.
- *Pipeline operations*. Pipeline operations employment of 1,828, including contract workers and special project employment, would end with the end of oil throughput in the beginning of 2004 (TAPS Owners 2001a).
- *Pipeline termination*. Termination activities would last for 6 years (2002 through 2007), and for the purposes of analysis, would begin in 2002 (which would allow sufficient time for an adequate planning process to occur if termination activities began immediately upon expiration of the Federal Grant and cessation of oil throughput). The 2-year period of planning would include an environmental review, supply deployment, and preparatory construction and would occur during 2002 and 2003. This would be followed by 3 years (2004, 2005, and 2006) of field activities, including pipeline cleaning and pumping, removal of the pipeline and pump stations and Valdez Marine Terminal, and scrap disposal. Demobilization activities would take an additional year (2007). Peak termination employment of 5,219 would occur in 2004, with a relatively large work force also being employed in 2005 (3,350) and 2006 (1,922) (TAPS Owners 2001a).
- *Oil field development activities*. All oil exploration, development, and production in the North Slope fields; construction of oil field equipment and supplies; and manufacture of replacement double-hulled tankers for the Alaska market would cease by 2004.
- *Government oversight of pipeline operations*. Employment in these activities would end with the conclusion of pipeline termination activities.

Assumptions about Other Activities in the Alaska Economy. These assumptions are as follows:

- *Key sectors*. Activities in the Alaska economy with significant employment growth potential (in particular, seafood processing, tourism, and air cargo) on average would continue to grow throughout the removal and postremoval period even though growth trends in some industries, notably seafood, can be cyclical in nature. Military employment would remain constant throughout the period. Employment in federal and state government, which is already significant, would remain stable until the end of the termination period, after which it would decline substantially.
- *State and local government finances*. Beginning in 2004, no additional North Slope oil revenues would be available to state and local governments; oil royalties paid to the Alaska Permanent Fund and any settlement payments made by oil companies to the Constitutional Budget Reserve Fund (CBRF) would also cease. While the analysis assumed that the CBRF would be used to cover the deficit through 2003, the absence of almost all state oil revenues would mean that significant additional sources of funds would be needed by the state to cover slowly increasing General Fund expenditures at the state and local levels. A sales tax, reinstitution of a state personal income tax, a cap on the Permanent Fund Dividend, changes in petroleum sector tax rates, reductions in state and local expenditures, and the use of some portion of the earnings

of the Permanent Fund are all being considered by the state legislature to cover increasing deficits. While a number of these, notably a personal income tax and the use of some portion of the earnings from the Permanent Fund, have already been proposed by various parties to address current state budgetary problems, the analysis does not include any of these options because of the uncertainty surrounding the likely use and timing of any particular fiscal policy option. The selection of any one, or combination, of policy options to address the budget deficit was, therefore, considered to be beyond the scope of this analysis.

4.6.2.19.2 National Economic Impacts. The economic impacts of the no-action alternative on the national economy would be limited to those caused by lost oil production from North Slope after 2003. These impacts would be in the areas of domestic oil production and national energy security, balance of trade, federal tax revenues, marine transportation, and overall economic activity in the United States.

Impacts of No-Action Alternative on National Economy

North Slope oil production currently contributes about 18% of domestic oil production, and although this contribution would have been expected to fall to about 14% by 2020 with the renewal of TAPS, the impact of the no-action alternative over the period 2004-2034 would still be substantial. In addition to a loss of domestic production, the no-action alternative would impact national energy security and the U.S. balance of trade in oil and would remove an important source of federal tax revenues. The no-action alternative would also impact the domestic marine transportation and shipbuilding industries.

Domestic Oil Production and National Energy Security. Continued operation of the TAPS and North Slope fields through 2034 would have contributed an additional 8.9 billion bbl of crude oil to U.S. domestic production (DOE 2001a). Even though the contribution of North Slope crude domestic oil supplies would have declined from 18% in 2004 to 14% in 2020 (DOE 2001b), North Slope production would still have made a substantial contribution to the reduction of U.S. dependency on foreign oil supplies. The no-action alternative, therefore, would substantially increase U.S. dependency on oil from outside the United States. U.S. dependency on foreign oil could create significant foreign policy issues if the countries supplying it were politically and/or economically unstable.

Balance of Trade. The United States will continue to be a net importer of crude oil over the period 2004 to 2034, with steady growth in domestic consumption and declining domestic production (DOE 2001b). The no-action alternative would worsen the U.S. balance of trade in oil. World oil price forecasts by DOE for each year in the period 2004 to 2034 indicate that North Slope production over the entire period would be valued at $374 billion in 2000 dollars (DOE 2001b). Despite the worsening negative trade balance that the United States has in oil, production from North Slope over the period 2004 to 2034 would have offset the increasing U.S. dependency on foreign oil; it would have reduced the dependency from 9.9 to 8.8 million bbl/d by 2004, a reduction of 11%, and from 11.2 to 10.5 million bbl/d by 2020, a reduction of 6% (DOE 2001b).

Federal Tax Revenues. Federal income taxes and royalties on federal lands would generate significant tax revenues for the federal government with continued operation of the TAPS and North Slope production. Over the entire renewal period, it is estimated that these revenues would have reached approximately $11.4 billion in 2000 dollars (ECA 1999a).

Marine Transportation. Under the proposed action, replacement of the current single-hulled fleet was expected to have created a demand for nine additional 125,000-ton double-hulled tankers by 2014 (ECA 1999b). Approximately $1.6 billion in 2000 dollars would have been spent in U.S. shipyards to accommodate North Slope transportation demand, thereby producing approximately 1,000 shipyard jobs per tanker (GAO 1999), with additional jobs being created in the various industries that supply shipyards with equipment, materials, and services. Maintenance activities would have also provided additional shipyard employment. Marine transportation would have also resulted in employment, with approximately 1,330 U.S. personnel required in 2004, a level that would have fallen to 530 by 2034 (TAPS Owners 2001a).

Overall Economic Activity. Current North Slope oil production has a smaller impact on the U.S. economy as a whole than it does on the U.S. oil production and transportation sectors. In the absence of North Slope production, the widespread availability of suitable oil from other sources (from either U.S. production or foreign suppliers) would enable refinery production and refinery product customer industries to continue. The benefits to U.S. consumers and to the federal government occurring when north slope oil is cheaper than imported oil would disappear, however.

4.6.2.19.3 State Economic Impacts. TAPS termination and the loss of North Slope production would affect the economy of Alaska by affecting the population (including net migration), gross state product, employment and unemployment, personal income, and state and local tax revenues.

Economic Impact Assessment

As described in Appendix A, Section A.8, the Man in the Arctic Program (MAP) computer model developed at the University of Alaska-Anchorage, Institute for Social and Economic Research, was used to assess potential economic impacts of the no-action alternative. The model uses three modules — an economic module, a demographic module, and a fiscal module — to evaluate possible impacts in those areas over the range of changing conditions being examined. The results discussed here for the no-action alternative cover the 30-year period 2004-2034 (the same period covered by the proposed Federal Grant renewal).

Population and economic impacts were estimated using the MAP Model (see text box). The impacts of TAPS termination and lost North Slope oil production would be substantial, with losses during the period 2004 to 2007 only partially and temporarily offset by moderate increases associated with TAPS termination activities. Although the economy of the state would begin to recover from the loss of the majority of the oil sector and supporting industries by the end of the nonrenewal period, by 2034 the economy would still remain well below the level of activity present in 2003 (see Figure 4.6-1).

Population. With the termination of TAPS and the end of North Slope production the state's population would continue to grow, at a moderate annual average rate of 1.2% over the entire period 2004 to 2034, with a slightly higher growth rate occurring between 2019 and 2034 (Table 4.6-12), mainly as a result of the fairly rapid growth of the Alaska Native population. Significant out-migration, primarily of the non-Native population, would be expected to occur, particularly between 2004 and 2019, as state tax revenues, employment, and personal incomes fall.

Gross State Product. GSP, which is the sum of value added in the production of all goods and services in a year, measures the level of economic activity in the state. Table 4.6-13 presents GSP in terms of constant dollars, which are used to exclude the effects of inflation in the economy and fluctuations in natural resource prices when GSP is compared over time. GSP in Alaska, measured in constant 2000 dollars, would experience a decline of almost 40% between 2003 and 2004 with the loss of oil production and state oil revenues. While the economy of the state is expected to recover to a certain extent, with a moderate overall increase in GSP of 0.7% over the period 2004 to 2034, and a slightly larger annual growth rate of 1.1% between 2019 and 2034, GSP would still not have reached its 2003 level by the end of the period.

Growth in GSP related to individual industries would still occur, despite the losses in the oil sector and supporting industries. Growth

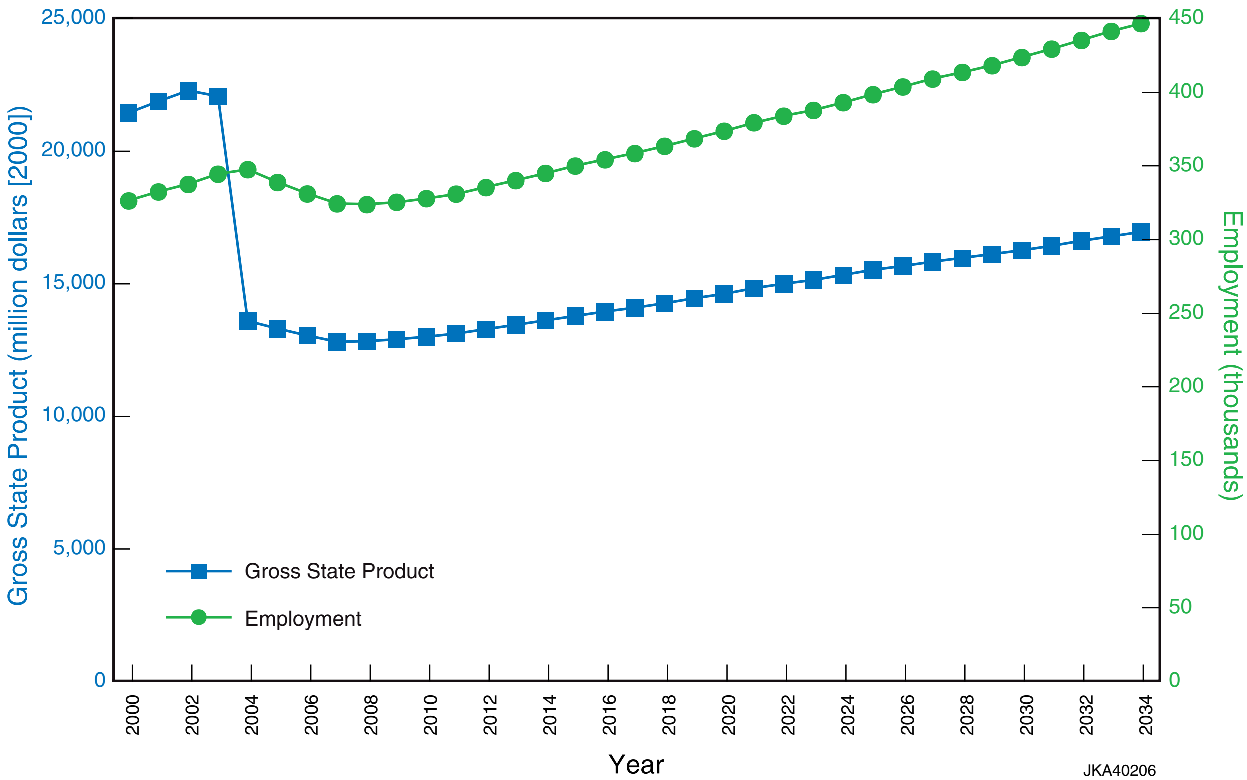

FIGURE 4.6-1 Alaska Gross State Product and Employment with TAPS Termination

TABLE 4.6-12 State Population Projections

Item	Year 2003	Year 2004	Year 2019	Year 2034	Average Annual Rate of Growth (%) 2004 to 2019	Average Annual Rate of Growth (%) 2019 to 2034	Average Annual Rate of Growth (%) 2004 to 2034
Alaska	670,692	682,887	781,773	974,183	0.9	1.5	1.2
Non-Native	508,574	517,864	563,335	675,593	0.6	1.2	0.9
Native	117,873	120,778	174,193	254,345	2.5	2.6	2.5
Military[a]	44,245	44,245	44,245	44,245	0.0	0.0	0.0
Net migration	8,558	5,568	4,992	3,394	-0.7	-2.5	-1.6
Net migration percent (%)	1.3	0.8	0.6	0.4	-1.6	-4.0	-2.8

a Includes active-duty personnel and their dependents.

Source: MAP model (see Appendix A, Section A.8).

TABLE 4.6-13 Projected Alaska Gross State Product by Industry (millions of 2000 dollars)

	Year				Average Annual Rate of Growth (%)		
Industry	2003	2004	2019	2034	2004 to 2019	2019 to 2034	2004 to 2034
Alaska	22,073	13,597	14,446	16,953	0.4	1.1	0.7
Mining (including Oil and Gas)	3,173	861	973	1,024	0.8	0.3	0.6
Agriculture, Forestry and Fisheries	598	599	613	620	0.2	0.1	0.1
Construction	1,414	2,167	999	1,122	-5.0	0.8	-2.2
Manufacturing	1,183	1,187	1,238	1,367	0.3	0.7	0.5
Transportation[a] (including Air Cargo)	2,864	2,821	3,276	4,246	1.0	1.7	1.4
Communications and Public Utilities	1,377	1,390	1,549	1,975	0.7	1.6	1.2
Wholesale and Retail Trade[a]	2,694	2,734	3,117	3,991	0.9	1.7	1.3
Finance	2,030	2,053	2,325	3,058	0.8	1.8	1.3
Services[a]	3,149	3,203	3,667	4,720	0.9	1.7	1.3
Tourism[a]	1,084	1,128	1,541	1,971	2.1	1.7	1.9
Federal Civilian	1,624	1,627	1,666	1,686	0.2	0.1	0.1
State Government	1,144	1,160	1,174	1,305	0.1	0.7	0.4
Local Government	1,688	1,666	1,723	1,992	0.2	1.0	0.6
Military	1,280	1,279	1,272	1,268	0.0	0.0	0.0

[a] Tourism total includes activity also included in Transportation, Trade, and Services. Data in Tourism row is not included in Alaska total.

Source: MAP model (see Appendix A, Section A.8).

would be concentrated among industries responding to continuing population growth in the state, especially communications, public utilities, trade, finance, and services. Growth in these sectors would average between 1.2 and 1.3% per year. Growth in tourism (2.1% per year during the first half of the period) and to a lesser extent transportation, which includes air cargo (1.7% per year during the second half of the period), would occur independently of the decline in oil and gas and the overall increase in state population, with the stimulus for these industries coming primarily from outside the state. Among the resource-based industries, forestry and fishing would experience growth rates lower than the state rate. Mining, which includes oil and gas, would experience massive losses between 2003 and 2004 with the end of

North Slope production. The sector would grow at a moderate rate toward the end of the first period, however, reflecting fairly rapid development of the non-oil-and-gas portion of the sector.

The construction sector would experience significant short-term growth during the termination period (2004–2007), reflecting pipeline termination activities. This would be followed by considerable contraction of the sector, with moderate growth occurring during the second half of the period.

GSP related to federal government activity would grow slightly over the entire period with only 0.1% in overall annual growth; state and local GSP activity would each grow, with annual increases of 0.4 and 0.6%, respectively. Slightly lower federal GSP growth would be experienced during the second half of the period, and a moderate increase in both state and especially local government GSP growth would occur in the second half of the period.

Employment. A small overall gain of employment in Alaska is expected with the end of North Slope oil production in 2004, with the impact of lost North Slope production offset in the first 3 years of the nonrenewal period by increases in construction employment associated with termination activities. Employment would grow at an annual average rate of 0.8% over the entire period 2004 to 2034, with slightly higher growth occurring between 2019 and 2034 (Table 4.6-14). A number of industries would outpace the state rate, including transportation, trade, finance, services, and tourism, each of which would grow between 1.3 and 1.9% each year over the entire period. With the exception of tourism, each of these industries would experience higher growth rates during the second half of the period. The natural-resource-based industries, such as mining (which includes the oil and gas sector), agriculture, forestry, and fishing, would all grow at close to the state average rate for the entire nonrenewal period and would all experience higher growth rates during the first half of the period.

After expanding at the very beginning of the first half of the period, reflecting pipeline termination activities, and subsequently declining, the construction sector would experience moderate employment growth during the second half of the period, reflecting growth rates in the economy of the state as a whole.

Employment in federal, state, and local government is expected to produce less employment growth than would be the case for the state as a whole, with overall rates of 0.6% for local government, 0.4% for state government, and 0.2% for federal government employment. Higher state and local government employment growth rates are expected during the second half of the period 2004 to 2034, with falling rates for federal government employment.

Unemployment. While unemployment in the state initially resulting from lost oil production would be only moderate, relatively higher unemployment rates would be expected to persist over the period 2004 to 2034, as tax revenues and the remainder of the state economy were significantly affected. The unemployment rate would be 7% in 2004 and would not drop below 7.0% over the entire period (Table 4.6-15).

It is likely that the unemployment impacts underestimate the number of people who are projected to want to work, because the unemployment rate only includes persons who would be registering for unemployment benefits. During the nonrenewal period, the number of employment opportunities in many Alaskan communities is likely to continue to be limited, meaning that additional people would not be actively searching for employment.

Personal Income. Real personal income (which excludes the effects of inflation on personal incomes over time) would only be moderately affected by the loss in oil production and oil revenues. Personal incomes would be expected to grow, increasing at an annual average rate of 1.2% over the entire period, with a higher rate in the second half of the period (Table 4.6-16). Per capita incomes would fall slightly over the first period before rising in the second period, with a negligible average annual growth rate over the entire period. The contribution of transfer payments to personal

TABLE 4.6-14 Projected Employment in Alaska by Industry

	Year				Average Annual Rate of Growth (%)		
Industry	2003	2004	2019	2034	2004 to 2019	2019 to 2034	2004 to 2034
Alaska	344,484	347,566	368,523	446,725	0.4	1.3	0.8
Mining (including Oil and Gas)	10,157	4,329	4,895	5,149	0.8	0.3	0.6
Agriculture, Forestry and Fisheries	1,991	2,011	2,370	2,546	1.1	0.5	0.8
Construction	16,963	23,485	13,128	14,901	-3.8	0.9	-1.5
Manufacturing	15,449	15,465	15,683	16,059	0.1	0.2	0.1
Transportation[a] (including Air Cargo)	20,997	20,683	23,961	30,919	1.0	1.7	1.4
Communications and Public Utilities	6,415	6,456	6,951	8,206	0.5	1.1	0.8
Wholesale and Retail Trade							
Trade[a]	64,014	65,000	74,363	95,171	0.9	1.7	1.3
Finance	12,638	12,781	14,531	19,268	0.9	1.9	1.4
Services[a]	75,460	76,789	88,187	114,199	0.9	1.7	1.3
Tourism[a]	18,651	19,422	26,510	33,922	2.1	1.7	1.9
Federal Civilian	17,560	17,604	18,126	18,401	0.2	0.1	0.2
State Government	21,413	21,710	21,985	24,514	0.1	0.7	0.4
Local Government	33,462	33,009	34,166	39,595	0.2	1.0	0.6
Military	18,054	18,054	18,054	18,054	0.0	0.0	0.0
Proprietors	29,912	30,192	32,123	39,743	0.4	1.4	0.9

[a] Tourism total includes activity also included in Transportation, Trade, and Services. Data in Tourism row is not included in Alaska total.

Source: MAP model (see Appendix A, Section A.8).

TABLE 4.6-15 Projected Labor Force Participation and Employment and Unemployment Rates

	Year				Average Annual Rate of Growth (%)		
Parameter	2003	2004	2019	2034	2004 to 2019	2019 to 2034	2004 to 2034
Total population	670,692	682,887	781,773	974,183	0.9	1.5	1.2
Potential labor force	465,454	473,001	514,545	634,885	0.6	1.4	1.0
Labor force	362,468	368,007	395,224	483,465	0.5	1.4	0.9
Labor force participation rate (%)	78	78	77	76	-0.1	-0.1	-0.1
Employment[a]	338,771	342,209	366,858	446,088	0.5	1.3	0.9
Unemployment rate (%)	6.5	7.0	7.2	7.7	0.2	0.5	0.3

[a] Employment of Alaskan residents; does not include nonresidents.

Source: MAP model (see Appendix A, Section A.8).

TABLE 4.6-16 Projected State Personal Income and Alaska Permanent Fund Dividend (2000 dollars, except where noted)

	Year				Average Annual Rate of Growth (%)		
Parameter	2003	2004	2019	2034	2004 to 2019	2019 to 2034	2004 to 2034
Total personal income (PI) (millions of 2000 dollars)	16,114	16,255	18,167	23,235	0.7	1.7	1.2
Personal income per capita	24,026	23,804	23,238	23,851	-0.2	0.2	0.0
Transfer payments per capita	5,920	5,832	7,177	7,669	1.4	0.4	0.9
Transfer payments share of personal income (%)	24.6	24.5	30.9	32.2	1.6	0.3	0.9
Permanent Fund Dividend per capita	1,208	1,069	1,166	965	0.6	-1.3	-0.3
Permanent Fund Dividend share of personal income (%)	5.0	4.5	5.0	4.1	0.7	-1.4	-0.4

Source: MAP model (see Appendix A, Section A.8).

incomes would grow from more than 25% of incomes in 2004 to more than 32% by 2034.

With the end of North Slope oil production and pipeline operation, Alaska Permanent Fund Dividend payments (the per capita annual payment to individuals by the state from earnings on the investment of royalty payments made to the state by oil companies), would still be made. The size of the Permanent Fund Dividend depends on the performance of the stock market and the extent to which investment earnings are also used to cover state General Fund expenditures. Assuming no increase in the current portion of earnings going to the General Fund, the Permanent Fund Dividend would contribute 4.5% of personal income in 2004, with a small decline in the contribution of the per capita payment as population growth in the state exceeds growth in the size of the Permanent Fund.

State and Local Tax Revenues. The largest impact of not renewing the Federal Grant would be on tax revenues. Oil revenues currently contribute almost one-third of total state revenues and have been a major source of revenues used to support a wide range of expenditure programs. In 2004, total state oil revenues would fall to less than 10% of their level in the last year of pipeline operations in 2003 (Table 4.6-17). The loss of production taxes and corporate income taxes would be particularly significant; they would fall to less than 5% of their 2003 levels. The overall impact on the state budget would be a reduction of more than 25% in state revenues by 2004.

Impacts of No-Action Alternative on Tax Revenues

Loss of North Slope oil would have a substantial effect on state tax revenues in 2004, reducing oil revenues by more than 90% and oil production and oil-related corporate income tax revenues by more than 95%. Overall state revenues would fall by 25%, but with a less than 10% decline likely at the local level. Although some growth in state revenues would be expected from nonpetroleum sources, these sources would not be enough to cover projected expenditures.

While small annual increases in nonpetroleum revenues of 0.4% over the entire nonrenewal period would be partially expected to offset the loss in oil revenues, it is projected that overall tax revenues in the state would decrease at an annual average rate of 1.5% over the 30-year period. The rate of decline in total revenues would be larger without the benefit of earnings on the investment of general revenues. By 2034, these earnings are projected to disappear, with some spending of the principal likely. If the projected level of state and local expenditures occurs (see below), increasingly large annual budget deficits are likely during the nonrenewal period if, as it is assumed, the current means of generating revenue in the state continue.

Options for Addressing the Deficit

Various fiscal policy options have been identified as a means of addressing current revenue shortfalls, including a sales tax, reinstitution of a state personal income tax, a cap on the Permanent Fund Dividend, changes in petroleum sector tax rates, state and local expenditure reductions, and the use of a portion of the earnings on the Permanent Fund, currently used for the Permanent Fund Dividend. While a number of these, notably a personal income tax and the use of some portion of the earnings from the Permanent Fund, have already been proposed to address current state budgetary problems, the analysis does not include any of these options in the estimation of the impact of not renewing the Federal Grant on state and local tax revenues because of the uncertainty surrounding the use and timing of any particular fiscal policy option. The selection of any one, or a combination of, these policy options to address the budget deficit was considered to be beyond the scope of this analysis.

The loss of oil production and the end of pipeline operations would only have a moderate impact on the ability of local governments to maintain existing service levels. This conclusion is reached because the analysis assumed that state transfers to local governments would not be affected by the loss of state oil revenues with the nonrenewal of TAPS. Although increasingly large state budget deficits are projected with the

TABLE 4.6-17 Projected State Revenues[a] (millions of 2000 dollars)

Industry	Year 2003	Year 2004	Year 2019	Year 2034	Average Annual Rate of Growth (%) 2004 to 2019	2019 to 2034	2004 to 2034
Total oil revenues	1,451	106	138	113	1.8	-1.4	0.2
Bonuses	17	1	2	2	3.6	-1.2	1.2
Rents	16	16	16	17	0.2	0.2	0.2
Property taxes	39	2	1	1	-7.2	-2.5	-4.9
Royalties	699	57	74	56	1.8	-1.8	-0.1
Production taxes	407	16	33	26	5.0	-1.8	1.6
Corporate taxes	151	2	1	0	-7.7	-3.0	-5.4
Miscellaneous petroleum revenues	113	0	0	0	NA[b]	NA	NA
Federal-state shared petroleum revenues	11	11	11	11	0.2	0.2	0.2
Nonpetroleum revenues	451	452	457	516	0.1	0.8	0.4
Investment earnings	1,874	1,873	1,100	-101	-3.5	-185.3	NA
Federal grants	1,224	1,277	1,560	1,862	1.4	1.2	1.3
Total state revenues	5,001	3,707	3,256	2,389	-0.9	-2.0	-1.5

[a] Components may not exactly add up to total because of independent rounding.

[b] NA = not applicable.

Source: MAP model (see Appendix A, Section A.8).

current means of generating revenue (see above) and although there is considerable uncertainty regarding the choice of any particular option to increase revenues or reduce expenditures at the state level and the consequent impact on state transfers to local governments, the analysis assumed that the necessary state revenues would be found to support projected local government expenditures over the nonrenewal period. On the basis of this assumption, overall revenues at the local level would fall by 10% between 2003 and 2004. The largest loss would be to taxes levied on oil property, which would fall to only 6% of their 2003 level by 2004 (Table 4.6-18). The share of oil-related property tax revenues would continue to fall during the termination period, from 2.3% of total property tax revenues in 2004 to 0.3% by 2034.

Overall, losses are not expected to be as significant at the local level as they are at the state level, although losses would be large in some areas, such as the North Slope Borough, where petroleum taxes account for a large share of revenues. Local tax revenues are expected to grow at an annual average rate of 0.7% over the entire period, with larger increases occurring over the second 15 years (Table 4.6-18). Federal and state transfers to local government, which together would constitute about 45% of total local revenues over the entire period, are expected to grow at a relatively stable rate — a rate only slightly less than the overall growth rate in general revenues at the local level.

TABLE 4.6-18 Projected Local Revenues[a] (millions of 2000 dollars, except where noted)

	Year				Average Annual Rate of Growth (%)		
Revenue Source	2003	2004	2019	2034	2004 to 2019	2019 to 2034	2004 to 2034
Local revenues[b]	1,958	1,799	1,947	2,349	0.5	1.3	0.9
Property taxes[c]	697	529	604	810	0.9	2.0	1.4
Petroleum	189	12	4	3	-7.3	-2.4	-4.8
Nonpetroleum	508	517	601	807	1.0	2.0	1.5
Petroleum percent of total property taxes (%)	27.1	2.3	0.7	0.3	-8.1	-4.2	-6.2
Other taxes	156	159	185	249	1.0	2.0	1.5
State transfers	971	975	996	1,098	0.2	0.7	0.4
Federal transfers	134	136	161	192	1.1	1.2	1.2
Charges and miscellaneous revenue	740	636	646	666	0.1	0.2	0.2
Total general revenues[d]	2,699	2,435	2,593	3,015	0.4	1.0	0.7

[a] Components may not exactly add up to total because of independent rounding.

[b] Local revenues are the sum of property and other taxes, plus state and federal transfers.

[c] Property taxes are the sum of petroleum and non-petroleum property taxes.

[d] Total general revenue is the sum of local revenues and charges and miscellaneous revenues.

Source: MAP model (see Appendix A, Section A.8).

State and Local Expenditures. State government expenditures are expected to grow at an annual rate of 0.4% over the entire nonrenewal period, with higher growth during the second half of the period (Table 4.6-19). Expenditures on education would grow from about one-fifth of overall state spending in 2004 to slightly less than one-third in 2034. These expenditures would be growing at an annual rate of 0.5% over the entire renewal period, with higher growth during the second half of the period. General government (0.5%) and social services (0.9%) are also expected to grow slightly faster than overall state expenditures, also with higher growth during the second half. Despite the growth in education spending, education expenditures are not expected to keep pace with population growth, resulting in a 0.7% decline in per capita expenditures over the entire nonrenewal period, while overall state per capita expenditures would also be expected to decrease at an annual rate of 0.8%.

At the local level, growth in educational expenditures for the nonrenewal period (0.8%) is expected to be higher than the overall rate of local expenditure growth (0.6%) (Table 4.6-20). As a result, educational expenditures would continue to make up a large portion of total expenditures, increasing from 34% of all expenditures in 2004 to 38% in 2034. As is the case at the state level, however, expenditures on education are not expected to keep pace with

Table 4.6-19 State Government Expenditures (millions of 2000 dollars, except where noted)

Item	Year				Average Annual Rate of Growth (%)		
	2003	2004	2019	2034	2004 to 2019	2019 to 2034	2004 to 2034
General government	895	898	925	1,046	0.2	0.8	0.5
Education	1,804	1,809	1,868	2,114	0.2	0.8	0.5
Social services	902	907	976	1,170	0.5	1.2	0.9
Transportation	523	523	517	552	-0.1	0.5	0.2
Environment	339	340	349	392	0.2	0.8	0.5
Capital outlay and debt service	1,387	1,324	1,008	1,161	-1.8	1.0	-0.4
Total state expenditures	5,849	5,801	5,643	6,435	-0.2	0.9	0.4
Expenditures per capita (2000 dollars)	8,720	8,495	7,218	6,606	-1.1	-0.6	-0.8

Source: MAP model (see Appendix A, Section A.8).

Table 4.6-20 Local Government Expenditures (millions of 2000 dollars, except where noted)

Item	Year				Average Annual Rate of Growth (%)		
	2003	2004	2019	2034	2004 to 2019	2019 to 2034	2004 to 2034
Education	1,261	1,271	1,354	1,613	0.4	1.2	0.8
Noneducation expenditures	932	929	922	965	-0.1	0.3	0.1
Personnel expenditures	1,294	1,209	1,304	1,489	0.5	0.9	0.7
Interest on debt	274	157	139	204	-0.8	2.6	0.9
Total expenditures	3,760	3,566	3,719	4,271	0.3	0.9	0.6
Expenditures per capita (2000 dollars)	5,607	5,222	4,757	4,385	-0.6	-0.5	-0.6

Source: MAP model (see Appendix A, Section A.8).

population growth, meaning that per capita expenditures would decline by 0.4% over the entire nonrenewal period. Overall local per capita expenditures are also expected to decrease at an annual rate of 0.6%.

4.6.2.19.4 Pipeline Corridor Regional Economic Impacts. TAPS removal and lost North Slope oil production would affect the economy of the pipeline corridor region by affecting the population (including net migration), employment, personal income, and local government revenues and expenditures and public service employment. While economic activity in the pipeline corridor would change with the loss of the TAPS, the overall level of activity in the region is not expected to be as closely related to lost TAPS throughput over the nonrenewal period as is likely to be the case at the state level. In the pipeline corridor, as is the case at the local level elsewhere in the state, transfers to local jurisdictions create significant local employment and income. In addition, transfers from federal sources, together with steady growth in population and income in the Alaska Native community independent of TAPS, provide additional spending power in the local economies in the region.

The analysis assumed that state transfers to local governments would not be affected by reductions in state oil revenues with lost TAPS throughput. While increasingly large state budget deficits are projected with the current means of generating revenue, a number of fiscal policy options have been considered by various parties to address the current and likely future fiscal situation (see Section 4.3.19.3.5). Given the uncertainty surrounding the use and timing of any particular option to increase revenues or reduce expenditures, however, and the consequent impact on state transfers to local governments, the analysis assumed that the necessary state revenues would be found to support projected local government expenditures over the nonrenewal period.

Population. Some variation in population growth is expected within the pipeline corridor region following TAPS termination and the loss of North Slope oil production; over the entire renewal period, slightly lower growth rates are projected for the pipeline corridor as a whole (1.1%) than for the state as a whole (1.2%). Within the pipeline corridor, annual average growth rates would range from 0.1 to 1.4%, with slightly higher rates expected for the Southeast Fairbanks and Yukon-Koyukuk Census Areas and lower rates expected for the Valdez Cordova Census Area (Table 4.6-21). Larger growth rates are expected throughout the pipeline corridor region in the second half of the renewal period.

Employment. Following a small increase in overall employment of 1% between 2003 and 2004, moderate employment growth of 0.8% would occur in the pipeline corridor as a whole between 2004 and 2034. The North Slope Borough would experience an almost 20% loss in employment between 2003 and 2004 with additional losses in the first half of the nonrenewal period. Smaller losses are expected in the Valdez-Cordova Census Area. Slightly higher-than-average rates of growth over the entire period are expected in the Southeast Fairbanks and Yukon-Koyukuk Census Areas and in Anchorage (Table 4.6-22).

Personal Income. After declining 3% between 2003 and 2004, real per capita income in the pipeline corridor as a whole (adjusted for the effects of inflation) would increase slightly, on average, over the entire period 2004 to 2034, with slightly larger increases in per capita income in the Yukon-Koyukuk and Valdez Cordova Census Areas (Table 4.6-23). Annual growth rates in the North Slope and Fairbanks North Star Boroughs and in the Southeast Fairbanks Census Area would be expected to decrease during the first half of the period following the loss of oil production. All areas in the pipeline corridor region would experience slight increases in per capita income during the second half of the period.

Local Government Revenues and Expenditures and Public Service Employment. Population, employment, and personal incomes in the pipeline corridor region are generally expected to experience moderate growth over the first half of the nonrenewal period, with all parts of the region experiencing growth in the second half. At the state level, the

TABLE 4.6-21 Projected Populations in Pipeline Corridor Region[a,b]

Location	Year 2003	Year 2004	Year 2019	Year 2034	Average Annual Rate of Growth (%) 2004 to 2019	Average Annual Rate of Growth (%) 2019 to 2034	Average Annual Rate of Growth (%) 2004 to 2034
Total pipeline corridor	402,973	411,724	465,212	577,866	0.8	1.5	1.1
Anchorage	281,679	286,191	326,602	409,012	0.9	1.5	1.2
Fairbanks North Star Borough	86,933	88,669	100,559	121,938	0.8	1.5	1.1
North Slope Borough	7,462	7,445	7,782	9,670	0.3	1.5	0.9
Southeast Fairbanks Census Area	7,452	7,701	9,019	11,010	1.1	1.3	1.2
Valdez Cordova Census Area	11,082	13,237	10,944	13,473	-1.3	1.4	0.1
Yukon-Koyukuk Census Area	8,366	8,481	10,306	12,762	1.3	1.4	1.4

[a] Components may not exactly add up to total because of independent rounding.

[b] The MAP model results are shown for census area population projections up to 2025. For the period 2026 to 2034, the pipeline corridor population estimates were determined by using the annual state population growth rates for that period.

Source: MAP model (see Appendix A, Section A.8).

TABLE 4.6-22 Projected Pipeline Corridor Employment[a]

Industry	Year 2003	Year 2004	Year 2019	Year 2034	Average Annual Rate of Growth (%) 2004 to 2019	Average Annual Rate of Growth (%) 2019 to 2034	Average Annual Rate of Growth (%) 2004 to 2034
Total pipeline corridor	225,102	227,359	236,615	288,113	0.3	1.3	0.8
Anchorage	162,746	163,488	176,514	218,723	0.5	1.4	1.0
Fairbanks North Star Borough	42,804	44,431	44,674	51,410	0.0	0.9	0.5
North Slope Borough	8,511	7,097	4,310	4,993	-3.3	1.0	-1.2
Southeast Fairbanks Census Area	2,011	2,035	2,289	2,624	0.8	0.9	0.9
Yukon-Koyukuk Census Area	3,122	3,140	3,499	4,074	0.7	1.0	0.9
Valdez-Cordova Census Area	5,908	7,167	5,329	6,290	-2.0	1.1	-0.4

[a] Components may not exactly add up to total because of independent rounding.

Source: MAP model (see Appendix A, Section A.8).

TABLE 4.6-23 Projected Pipeline Corridor Personal Incomes (2000 dollars, except where noted)

	Year				Average Annual Rate of Growth (%)		
Industry	2003	2004	2019	2034	2004 to 2019	2019 to 2034	2004 to 2034
Total pipeline corridor							
Personal income per capita	25,029	24,367	24,352	25,019	0.0	0.2	0.1
Permanent Fund Dividend per capita	1,208	1,069	1,166	965	0.6	-1.3	-0.3
Permanent Fund Dividend share of personal income (%)	4.8	4.4	4.8	3.9	0.6	-1.4	-0.4
Anchorage							
Personal income per capita	27,096	26,407	26,452	26,961	0.0	0.1	0.1
Permanent Fund Dividend per capita	1,208	1,069	1,166	965	0.6	-1.3	-0.3
Permanent Fund Dividend share of personal income (%)	4.5	4.0	4.4	3.6	0.6	-1.4	-0.4
Fairbanks North Star Borough							
Personal income per capita	20,239	20,047	19,528	20,223	-0.2	0.2	0.0
Permanent Fund Dividend per capita	1,208	1,069	1,166	965	0.6	-1.3	-0.3
Permanent Fund Dividend share of personal income (%)	6.0	5.3	6.0	4.8	0.8	-1.5	-0.4
North Slope Borough							
Personal income per capita	18,818	17,002	14,741	15,256	-1.0	0.2	-0.4
Permanent Fund Dividend per capita	1,208	1,069	1,166	965	0.6	-1.3	-0.4
Permanent Fund Dividend share of personal income (%)	6.4	6.3	7.9	6.3	1.5	-1.5	0.0
Southeast Fairbanks Census Area							
Personal income per capita	19,348	18,475	18,397	18,971	-0.0	0.2	0.1
Permanent Fund Dividend per capita	1,208	1,069	1,166	965	0.6	-1.3	-0.3
Permanent Fund Dividend share of personal income (%)	6.2	5.8	6.3	5.1	0.6	-1.5	-0.4
Valdez-Cordova Census Area							
Personal income per capita	22,365	20,381	22,335	23,206	0.6	0.3	0.4
Permanent Fund Dividend per capita	1,208	1,069	1,166	965	0.6	-1.3	-0.3
Permanent Fund Dividend share of personal income (%)	5.4	5.2	5.2	4.2	-0.0	-1.5	-0.8

TABLE 4.6-23 (Cont.)

Industry	Year 2003	Year 2004	Year 2019	Year 2034	Average Annual Rate of Growth (%) 2004 to 2019	2019 to 2034	2004 to 2034
Yukon-Koyukuk Census Area							
Personal income per capita	19,376	18,737	19,477	20,269	0.3	0.3	0.3
Permanent Fund Dividend per capita	1,208	1,069	1,166	965	0.6	-1.3	-0.3
Permanent Fund Dividend share of personal income (%)	6.2	5.7	6.0	4.8	0.3	-1.5	-0.6

Source: MAP model (see Appendix A, Section A.8).

loss of TAPS throughput is expected to contribute to a steadily worsening state deficit. However, the analysis assumed that the required revenue from various possible sources would be found to fund state expenditures, including state transfers to local governments. With the availability of state funds for local expenditure programs, together with moderate population and economic growth in the pipeline corridor region, the impact of not renewing the Federal Grant on local public finances and public service employment in the region is, therefore, not expected to be significant.

4.6.2.19.5 Alaska Native Corporations. A number of Alaska Native corporations provide contracting services to the pipeline (see Section 3.23.6). These services would no longer be provided upon the termination of the pipeline, thus significantly impacting the employment and incomes of members of these Alaska Native corporations. A moderate decline in the size of the Permanent Fund Dividend per capita, as growth in the Alaskan population exceeded growth in the size of the Fund, would have a minor effect on personal incomes of corporation shareholders. Earnings on investments made by some of the corporations have the potential to partially offset the slight decline in personal incomes.

4.6.2.19.6 Subsistence. Lost oil production and oil revenues in 2004 and beyond would affect subsistence through the slight decline in per capita Permanent Fund Dividend support to personal incomes in the Alaska Native community. Growth in the Alaska population as a whole would exceed the growth of the Permanent Fund. Income from the dividend has led to some changes in the way subsistence activities (in particular, hunting and fishing) have been undertaken by further encouraging the use of modern equipment to supplement more traditional forms of subsistence. Losses in personal income with the slight decline of the Permanent Fund Dividend could affect the productivity of subsistence activities and create other socioeconomic impacts.

4.6.2.20 Subsistence

It is likely that the no-action alternative would result in small positive impacts on subsistence. This conclusion is based on the consideration of separate consequences that individually could lead to either an improvement or a deterioration in subsistence but that likely would, in sum, result in a very slight net improvement. Each of these consequences is examined below.

Impact of No-Action Alternative on Subsistence

Implementation of the no-action alternative could result in (1) reduced financial ability to pursue recreational hunting and fishing, (2) reduced access to subsistence hunting and fishing areas by nonlocals, (3) reduced ability to use the Dalton Highway (although the highway would remain), (4) increased economic reasons to pursue subsistence, (5) reduced restrictions to very small portions of traditional subsistence harvest areas, and (6) reduced activity on the Dalton Highway and near the TAPS that possibly has very slightly disrupted the movement of terrestrial mammals.

One of the main concerns among rural Alaskans pursuing subsistence as part or all of their means of survival is the depletion of resources by nonlocal competition. This nonlocal competition requires certain preconditions if it is to pose a serious threat:

- The number of nonlocal people fishing, hunting, or trapping would have to be large enough to deplete resources noticeably.
- Harvest locations, which were possibly previously isolated or at least generally inaccessible to nonlocal competitors, would have to be adequately accessible to enable noticeable depletion of resources or disruption of subsistence activities.

It has long been viewed by individuals who are involved in subsistence activities and by those who monitor subsistence that the TAPS provides both of these preconditions (e.g., Haynes 2000; Holly 1992; Ned 1992), although the relationship of the TAPS with them is largely indirect. Many believe that large numbers of people come from other locations in Alaska, often identified as cities such as Fairbanks or Anchorage, to pursue game or fish that also serve as key subsistence resources. TAPS employees have also been accused by subsistence practitioners of competing for fish and game (see Section 3.24), although no evidence exists to indicate that such competition (if present) results in harvest of enough resources to be a threat worthy of concern (see also Section 4.3.20). Increased access, in turn, is seen to result primarily from the Haul Road/Dalton Highway, and secondarily from TAPS-specific access roads.

As noted elsewhere in this DEIS, the Dalton Highway currently is owned and maintained by the State of Alaska and is open to the public. The no-action alternative is not anticipated to change this situation, although traffic could decline on this road for three reasons if the ROW is not renewed. One would be the reduction in commercial traffic that services the TAPS and North Slope oil fields. A second reason would be the declining road conditions resulting from reduced state revenues under the no-action alternative. Reduced revenues would likely lead to a reduction in maintenance on a road requiring frequent attention. The third reason for reduced traffic on Dalton Highway under the no-action alternative would be a decline in the financial resources of Alaska residents who might use it, a result of the adverse economic impacts anticipated to accompany the closure of the TAPS (see Section 4.6.2.19).

Population is anticipated to grow slowly under the no-action alternative, both in the state as a whole and in the corridor (see Tables 4.6-12 and 4.6-15). However, economic conditions anticipated under this alternative likely would yield mixed effects on subsistence. One impact would be increased pressure on subsistence as an economic activity in place of reduced alternatives for wage labor. Such pressure logically would lead to increased subsistence activity, at least by those individuals living in rural parts of the state. In addition, Alaska Natives would account for a disproportionately large percentage of the anticipated population growth through 2034, possibly leading to an increase in subsistence harvests because Natives have shown traditionally high involvement in this activity. In contrast, reduced access to cash due to anticipated slight declines in personal income (see Tables 4.6-16 and 4.6-23) would compromise at least to some degree modern subsistence activities. As discussed in Section 3.24.2, subsistence in the 21st century often involves the use of some sort of modern transportation technology along with some type of modern harvesting equipment. Many of these resources likely would be less available because of declines in income. Finally, under the no-action alternative, presumably fewer Alaska residents would be able to afford recreational hunting or fishing, reducing what today many subsistence practitioners view as a major source of competition. Ultimately then, economic conditions under the no-action alternative would yield a slightly greater impetus to pursue subsistence resources, but a slightly reduced ability to do so, and a slightly increased inability to pursue recreational hunting or fishing.

Finally, the no-action alternative would remove two of the direct effects of the TAPS that likely have slight negative impacts on subsistence:

- Limited access to (very small) parts of traditional subsistence harvest areas (because of the presence of TAPS infrastructure and activities); and
- The continued use of the Dalton Highway to maintain TAPS operations, along with various access roads and airspace over the TAPS, and continued human activity around the TAPS — possibly disrupting the movement of small numbers of terrestrial mammals.

If the Federal Grant was not renewed, both of these impacts would disappear, likely producing a very slight positive effect on subsistence.

The results of the above considerations need to be weighed against each other. Economic conditions under the no-action alternative would produce an increased need to pursue subsistence. Demographic conditions similarly would indicate increased pressure on subsistence resources as population (particularly Alaska Natives) slowly increased. Statewide, however, there would be a reduced ability to harvest fish and game, either for sport or subsistence. Moreover, access to the TAPS area would likely decline, although it would not revert to conditions that existed before construction of the Haul Road. Finally, restrictions on access to small portions of subsistence harvest areas and activities along the Dalton Highway and near the TAPS that might very slightly disrupt the movement of terrestrial mammals would cease, presumably yielding slight improvements to subsistence. Adequate data do not exist to permit a quantitative analysis (or weighing) of subsistence impacts for the no-action alternative and arrive at clearcut conclusions regarding net effects. However, the analysis seems to indicate a general decline in pressure on subsistence resources and thus very slightly improved subsistence conditions.

4.6.2.21 Sociocultural Systems

4.6.2.21.1 Alaska Native Sociocultural Systems. In certain impact areas, this DEIS anticipates high and adverse consequences under the no-action alternative, particularly those associated with the economic effects of discontinuing the TAPS. As discussed in detail in Section 4.6.2.19, both because of Alaska's heavy reliance on the oil industry and the central role that the TAPS plays in this industry, the entire state would experience economic impacts of considerable magnitude as

Impacts of No-Action Alternative on Sociocultural Systems

The overall impacts of the no-action alternative on sociocultural systems would likely be negative and sufficiently large to be detectable.

Possible positive consequences would include (1) short-term access to cash employment in areas close to the TAPS; and (2) removal of some of the characteristics of modernization that possibly have increased social problems among Alaska Native sociocultural systems.

Possible negative consequences include (1) short-term increased exposure to relatively large numbers of nonlocal people in the vicinity of the TAPS, along with any social disruption that might accompany them during termination activities; (2) reduction or termination of state-funded programs and public services important to many rural communities and to both Native and non-Native sociocultural systems, because of declining state revenues; and (3) reduced access to wage employment, an important component of mixed rural economies.

a consequence of terminating the TAPS, particularly in declining gross state product and state tax revenues. One major long-term impact of the no-action alternative on Alaska Native sociocultural systems would be the reduction of many state-funded programs and infrastructure development (or maintenance), upon which many Alaska Natives rely (see Section 4.6.2.19). Another important negative impact would be the removal of some of the cash available to these sociocultural systems, thereby negatively affecting their mixed economies. However, these impacts would occur following a brief but considerable infusion of cash associated with TAPS termination activities. The latter activities would generate short-term impacts expected to have both positive and negative consequences, particularly for Alaska Native sociocultural systems close to the pipeline and its facilities.

The short-term impacts on Alaska Native sociocultural systems under the no-action alternative likely would be complex, with both positive and negative components in certain ways similar to those experienced by Natives in the proximity of the TAPS during its construction (Reckord 1979; Strohmeyer 1997). The arrival of large numbers of nonlocal peoples, largely non-Native, had a disruptive effect on the Alaska Native sociocultural systems in the vicinity of the TAPS during its construction. In particular, the infusion of large numbers of nonlocal peoples rapidly introduced new ideas and desires that often were difficult to assimilate in Alaska Native sociocultural systems, as well as problems with crime that affected Natives and non-Natives near the TAPS.

Fewer impacts from non-Native ideas and desires are anticipated during termination activities than occurred during construction, because Alaska Natives in the 21st century generally are much more aware of the non-Native world through increased contact, greater mobility, improved communication, and access to information through a range of media. However, the influx of many nonlocals and the problems that accompanied their arrival (such as crime and disruption of many daily activities), likely would resemble the construction period. Of course, the increased activity associated with termination activities would generate a large increase in available cash, some of which should be directly available to local and nonlocal Alaska Natives under the APSC's Native hiring provisions (APSC 1998d), and indirectly available through other wage-based employment. As discussed in Section 3.25.1, the effects of cash on Alaska Native sociocultural systems can be both positive and negative. Under the no-action alternative, these effects likely would be intensified in the short-term, both with the rapid infusion of wages and with their rapid disappearance once termination activities were complete.

It is likely that fewer impacts to Alaska Native sociocultural systems would occur in urban settings close to the TAPS than in rural settings, with the overall changes probably similar to those described for Fairbanks during TAPS construction (Dixon 1978; Strohmeyer 1997). The anticipation of lessened impacts in cities stems primarily from greater familiarity of Alaska Natives in such settings with non-Native society and economy. The short-term increase in crime in urban settings that may accompany the no-action alternative would affect Alaska Native sociocultural systems negatively, particularly if Natives themselves were involved.

Although of short duration, the potential short-term impacts to Alaska Native sociocultural systems in the vicinity of the TAPS under the no-action alternative likely would be negative and noticeable. Such systems struggle in the modern world to maintain themselves and their identity. Exposure to another boom-bust cycle of in-migration, accelerated economic activity, intense competition for work, out-migration, and economic decline quite possibly would compromise this maintenance.

Long-term impacts on Alaska Native sociocultural systems under the no-action alternative also would be mixed, but unlike short-term consequences likely would be experienced throughout the state. The description of Alaska Native sociocultural systems presented in this document depicts a collection of indigenous peoples who had developed remarkable abilities to survive throughout the many ecological challenges provided by the Alaskan natural environment (see Section 3.25). As also discussed, however, those systems have changed considerably over the past century or two. With the exception of groups on the north and south coasts (where bands relocated less frequently), all Native sociocultural systems examined here were originally composed of small nomadic bands that constantly changed composition as well as geographic location in their struggle for survival. This is no longer the case. If one views such systems as the primary means by which humans adapt to their physical and social surroundings, then the modern sociocultural systems of Alaska Natives are adaptations to a partially traditional and partially modern set of natural and social challenges (see Section 3.25).

Although many Alaska Natives continue to rely heavily on subsistence, all of these economies are mixed, and cash plays an important role. Access to cash, primarily through wage employment (when available) and the Permanent Fund Dividend, is important in maintaining such economies. Personal income is anticipated to decline under the no-action alternative (see Section 4.6.2.19). Although income is projected to rebound eventually in the years following TAPS termination, it would take several years to reach levels achieved during operation of the TAPS. It is likely that Alaska Natives would experience reductions in personal income along with the rest of the state's population. Throughout rural areas (and many urban settings as well) Alaska Natives make heavy use of various public services, programs, and infrastructure provided by the state but ultimately funded in large part by oil revenues. State-funded programs and services include a range of assistance under the state revenue sharing program, the safe communities (municipal assistance) program, legislative grants, and capital project matching grants, which provide funds to eligible communities for infrastructure development, infrastructure maintenance, and public services (ADCBD 2002a,b). Public expenditures likely would be greatly reduced under the no-action alternative. Given the rapid and dramatic economic and related changes expected to accompany the no-action alternative, the adaptive capabilities of modern Alaska Native sociocultural systems would be greatly challenged — even acknowledging that in a very real sense these systems would be returning to situations closer to their traditional roots.

One of the greatest challenges faced by any adaptive system, including sociocultural systems, is the need to adjust to rapidly changing conditions. Such has been the world of many Alaska Native sociocultural systems for at least the past half-century. The no-action alternative ultimately would reduce the pace of change once new economic conditions were established, helping to remove some of the strain of continually adjusting to shifting social surroundings. Although it is uncertain, the reduced pace of change under the no-action alternative might also remove some of the causes of several social problems experienced by Alaska Natives, such as suicides that often are associated with substance abuse (Hlady and Middaugh 1988; Kettl and Bixler 1991). However, the uncertain consequences of removing much of the cash from Alaska Native economies are such that social problems may continue — the need to compete and adapt to rapid change and unfamiliar social challenges in a sense replaced by a materially and economically more difficult life with fewer options and a diminished ability to acquire the goods and services desired (Mitchell 2001).

In lieu of examples of similar situations, the long-term impacts on Alaska Native sociocultural systems under the no-action alternative likely would be negative and large enough to be detectable. This conclusion is founded in part on impacts in those components of Native economic systems relying on wages. The disappearance of direct and indirect sources of income and the reduction of public services are anticipated to have an adverse effect on economies that rely on an infusion of cash to supplement subsistence activities and that rely on public expenditures to provide necessary services (particularly in rural settings).

4.6.2.21.2 Non-Native Sociocultural Systems. It is likely that non-Native sociocultural systems also would experience short- and long-term impacts under the no-action alternative. Short-term impacts would occur during the termination activities associated with discontinuing the TAPS and likely would be both intense and feature positive and negative components. These brief impacts would result from the temporary relocation of nonlocal workers to rural areas to participate in termination activities. Termination activities would generate more opportunities for cash income, both through employment on TAPS-related projects and as a result of the indirect economic benefits produced by growth in spending throughout local economies. As wage labor is both relatively difficult to secure in rural Alaska and an important component in non-Native mixed economies outside of the cities, additional wage labor would be a positive consequence of the no-action alternative.

However, the no-action alternative also would have negative short-term consequences for rural non-Native sociocultural systems. As discussed in Section 3.25.2, these systems have their roots in the pioneers, missionaries, and gold prospectors of the 19th and 20th centuries (Haycox 2002). They tend to consist of fairly isolated, closed communities of peoples who have chosen rural Alaska over more conventional geographic and social settings in America. The no-action alternative would generate short-term changes to rural Alaskans near the TAPS through introducing large numbers of nonlocal people to work on termination activities. Many of the impacts documented for the largely Native community of Copper Center during TAPS construction — such as an increased pace of life and a need to integrate unfamiliar nonlocal people within the local community (Reckord 1979) — likely would also occur in non-Native sociocultural systems under the no-action alternative. Such impacts occurred to a certain degree in the largely non-Native rural community of Wiseman during TAPS construction (Scott 1998).

Long-term impacts on non-Native socio-cultural systems under the no-action alternative would hinge on the considerable economic impacts anticipated to accompany the discon-tinuation of the TAPS (see Section 4.6.2.19). The out-migration from Alaska anticipated to accompany rapid economic decline could have serious impacts on the rural non-Native sociocultural systems for those who remain, if outmigrants include many rural residents. The impacts expected include the interruption of social interaction patterns and established behavior patterns that extend beyond purely economic effects. Large reductions in government revenues predicted under the no-action alternative would reduce the ability of the state to provide much needed public services in rural areas, as discussed in Section 4.6.2.21.1. Despite such likely impacts, because these non-Native sociocultural systems tend to be less well-defined social networks than collections of individuals with a history of self-reliance (Lounsbury 1992; Scott 1998), the magnitude of impacts may in a sense be dampened. This conclusion acknowledges that rural non-Natives live where they do by choice and share a heritage of individuality and survival under difficult conditions.

The short-term impacts on non-Native sociocultural systems under the no-action alternative likely would be negative and small. Unlike Alaska Native sociocultural systems, the non-Native sociocultural systems of rural Alaska have their roots in Euro-American sociocultural systems. Often this association is not so much in sharing certain distant historic roots as it is in actual connection with more conventional settings — particularly through recent migrants to rural places. As documented for Wiseman (Scott 1998), although changes occurred during TAPS construction, most were localized in time and space, and the community and the sociocultural system underlying it adjusted accordingly.

Long-term impacts on non-Native sociocultural systems likely would be negative and noticeable. This conclusion rests primarily upon the anticipated effects of the considerable widespread economic downturn expected to accompany the no-action alternative. Rural non-Native sociocultural systems tend to rely on cash to complement subsistence activities and on public expenditures to provide certain services deemed necessary even in rural settings, such as schools. Both would be compromised under the no-action alternative, contributing reduced though unknown amounts to these systems. Moreover, the widespread out-migration from Alaska projected for the state as a whole possibly would affect rural non-Native settings as well, if indeed it affects rural settings, primarily in the form of increased difficulty of maintaining rural sociocultural systems.

4.6.2.22 Cultural Resources

The no-action alternative could have an adverse effect on potentially significant cultural resources. The TAPS itself might be eligible for listing on the NRHP for its value as an example of engineering and construction achievement and its importance in the history of Alaska and the United States. Thus, if the TAPS is listed as a historically significant structural complex on the NRHP, its dismantling and removal could constitute an adverse impact. Under Section 106 of the NHPA (16 USC §470(f)), before any removal activities, APSC would have to coordinate with the Alaska SHPO to determine whether the TAPS is eligible as a significant property, and what, if any, mitigation procedures would be necessary.

Impacts of No-Action Alternative on Cultural Resources

Two separate categories of impacts to cultural resources could result from the no-action alternative. The first category would be the impacts on the pipeline itself from dismantlement and removal of the aboveground TAPS components. The development of the TAPS was a massive engineering and construction accomplishment, and the pipeline has played a historically important role in Alaska and in U.S. domestic oil production. As such, the pipeline itself may be eligible for listing on the National Register of Historic Places. In addition, the activities associated with dismantlement and removal would have the potential to damage other cultural resources, both known and unreported, in the vicinity of the ROW.

In both cases, consultation with the Alaska SHPO would be needed on a case-by-case basis to mitigate potential impacts to specific resources that are considered significant.

Other than the possible adverse effect on the TAPS itself as a significant historic property, the issues of concern with regard to cultural resources under the no-action alternative would be the same as those described for the proposed action (see Section 4.3.22). The activities involved in the dismantlement and removal of the pipeline components would have the highest likelihood of affecting cultural resources; this likelihood would decrease significantly once the pipeline was removed. The absence of a functioning pipeline would remove the need for ground-disturbing activities in many areas along the ROW, thus lessening the probability of adverse impacts on cultural resources once termination activities were completed. However, the absence of the pipeline would also reduce the amount of monitoring of known cultural resources, which could lead to increased impacts on cultural resources from recreational activities on and in the vicinity of the former ROW.

4.6.2.23 Land Uses and Coastal Zone Management

Under the no-action alternative the TAPS ROW would not be renewed, and termination activities, including the dismantling and removal of TAPS facilities and restoration of the land, would be conducted. The impact assessment for the no-action alternative was based on the assumptions discussed in Section 4.6.1.1. In addition, it was assumed that both access to and recreational use within the ROW corridor likely would be restricted during termination activities, even if the current security restrictions were eliminated.

4.6.2.23.1 Land Use

Land Ownership. No additional land would be needed under the no-action alternative. Valid ROWs for termination activities exist on all parcels except one, which is currently under negotiation. No impacts on land ownership categories (federal, state, and private) would occur as a result of a decision to not renew the TAPS ROW.

Land Use. The no-action alternative would have effects on federal, state, local, and private land use in the vicinity of the pipeline. The current rate of commercial, municipal, and residential development would be expected to decline. (See Section 4.6.2.19 for a discussion of

Impacts of No-Action Alternative on Land Uses and Coastal Zone Management

Land Uses: No impacts on land ownership would result if the TAPS ROW was not renewed. Any effects on federal, state, and private land use in the vicinity of the pipeline would be local in nature. The current rate of commercial, municipal, and residential development would be expected to decline. A decision to not renew the Federal Grant would not preclude continuation of wildlife habitat conservation or of military, mining, agricultural, and subsistence activities that currently occur in the vicinity of the pipeline. However, recreational use of the TAPS ROW corridor would likely be temporarily restricted during termination activities. Land use conflicts that have occurred on Native lands near the pipeline would end after completion of termination activities.

Coastal Zone Management: Termination activities conducted under the no-action alternative would comply with the ACMP statewide standards and with the enforceable policies in both the North Slope Borough and Valdez CMPs. Nonrenewal of the TAPS would represent the loss of activities associated with TAPS and related facilities that are currently permitted under the ACMP statewide standards and the two local CMPs. Upon completion of termination activities, land previously occupied by the TAPS and associated facilities would be available for other development activities, consistent with ACMP statewide standards and enforceable policies of the North Slope Borough and Valdez CMPs.

the economic impacts of the no-action alternative.) The no-action alternative would not preclude continuation of activities related to the conservation of wildlife habitat or the military, mining, agricultural, or subsistence activities that currently occur in the vicinity of the pipeline. However, recreational use of the TAPS ROW corridor would likely be temporarily restricted during termination activities. Land use conflicts that have occurred on Native lands near the pipeline would end after completion of termination activities.

Federal and state lands in the vicinity of the pipeline include National Parks; federally designated Wilderness Areas; National Wildlife Refuges; National Wild and Scenic Rivers; and state recreation areas, sites, and parks. These lands are used primarily for recreation, wildlife habitat conservation, and the protection and preservation of ecological resources. Past operation and maintenance of the TAPS have neither interfered with these land uses nor affected protected resources in ACECs managed by the BLM. Consequently, past trends indicate that dismantlement and removal of the pipeline and subsequent revegetation of the corridor would not be likely to interfere with or otherwise impact federal or state land uses, except for the imposition of a temporary restriction on recreation within the ROW corridor during these termination activities. Upon completion of termination activities, land use within the former TAPS ROW would be subject to BLM, state, and/or private policies and management (depending on ownership).

The operation and maintenance of the TAPS also have not interfered with military, mining, or agricultural activities. The pipeline crosses Fort Greely, Eielson AFB, and Fort Wainwright. Although termination activities could possibly have a short-term impact on military activities, interference with mining or agricultural activities would be unlikely. (See Section 4.6.2.20 for a discussion of impacts on subsistence from the no-action alternative.)

Access and use conflicts have occurred on Native lands along the southern half of the pipeline owned by Ahtna, Incorporated, and Chugach Corporation. Ahtna, Incorporated, which owns land south of Paxson, has experienced an increase in trespassing since the construction of the pipeline across its land (Hart 2002). Chugach Corporation, which owns land in the Valdez area, has been concerned that the existence of the TAPS on its land precludes other uses (Rogers 2002). Although continued trespassing on Ahtna land could occur during termination activities, it would be less likely because there would be access restrictions. Chugach's concern about the TAPS' precluding other uses on its lands could also continue under termination activities. However, upon completion of termination activities, trespassing on Ahtna land via former TAPS access roads would be reduced or eliminated, and the potential for precluding other use on Chugach's land would no longer exist.

The 400-mi Dalton Highway (built to service the TAPS), which increased access to remote areas north of the Yukon River, would remain whether or not the TAPS ROW was renewed. Airstrips constructed for TAPS development and maintenance would also likely remain in place, regardless of renewal status.

During termination activities, a spill of crude oil or some other petroleum product could occur and affect land use. The severity of the impact would be largely determined by the volume and location of the spill. Twelve potential spill scenarios developed for the no-action alternative are presented in Table 4.6-2.

The spill scenario with the greatest potential release is the rollover of a tanker truck carrying kerosene from the Williams North Pole Refinery to Prudhoe Bay. In this scenario, 8,000 gal (about 190 bbl) of kerosene would be released instantaneously. This type of spill has the potential to occur one or more times every 2 years at some point along the pipeline. If it occurred on land, kerosene would cover about 12 acres at a depth of 1 in. A spill into a water body would result in contamination problems downstream, with the extent largely determined by response efforts.

In both cases, minimal effects on land use would be expected to occur. Because kerosene volatilizes more quickly than most components of crude oil and is less persistent in the environment, the effects on land use would be similar to, but less severe than, those described in Section 4.4.4.17.1 for a spill of crude oil. The potential for future impacts on land use from a TAPS-related spill would no longer exist after completion of termination activities.

4.6.2.23.2 Coastal Zone Management. The TAPS ROW begins in the North Slope Borough coastal zone, which includes about 110 mi of the pipeline and related structures. The TAPS ends in the Valdez coastal zone, which encompasses about 25 mi of the pipeline and the Valdez Marine Terminal. In compliance with the ACMP, both coastal zones have fully approved CMPs that include enforceable policies to regulate development activities (State of Alaska 2001). Activities must also be consistent with applicable statewide ACMP standards. Implementation of the no-action alternative, which would include termination activities, would result in the loss of activities associated with the TAPS and its related facilities (including the Valdez Marine Terminal) as permitted activities within the North Slope Borough and Valdez coastal zones. Termination activities would comply with ACMP statewide standards and the enforceable policies in both the North Slope Borough and Valdez CMPs (North Slope Borough 1988; Valdez 1988). No new development, facilities, or activities would be associated with the no-action alternative (TAPS Owners 2001a). Upon completion of termination activities, land previously occupied by the TAPS and its related facilities would be available for other development activities, consistent with ACMP statewide standards and the North Slope Borough and Valdez CMPs.

Termination activities would entail the possibility that a spill of crude oil or some other petroleum product could occur and affect coastal resources. Both the North Slope Borough and Valdez CMPs recognize the risk of spills and require oil spill response plans (North Slope Borough 1988; TAPS Owners 2001a). The North Slope Borough CMP also requires risk analysis for various spill scenarios (North Slope Borough 1988). The TAPS complies with these requirements.

Twelve potential spill scenarios have been developed for the no-action alternative (Table 4.6-2). As discussed for land use above, the spill scenario with the greatest potential release during termination activities is the rollover of a tanker truck carrying kerosene from the Williams North Pole Refinery to Prudhoe Bay. Because kerosene volatilizes more quickly than most components of crude oil and is less persistent in the environment, the potential effects on coastal resources would be minimal and less severe than those described in Section 4.4.4.17.2 for a spill of crude oil. The potential for future impacts on coastal resources from a TAPS-related spill would no longer exist after completion of termination activities.

4.6.2.24 Recreation, Wilderness, and Aesthetics

Under the no-action alternative, the TAPS ROW would not be renewed, and termination activities, including dismantlement and removal of certain TAPS facilities and site restoration, would be conducted. The impact assessment for the no-action alternative was based on the assumptions discussed in Section 4.6.1.1. In addition, it was assumed that both access to and recreational use within the ROW corridor likely would be restricted during termination activities.

4.6.2.24.1 Recreation. Implementation of the no-action alternative would have mostly local and temporary impacts on recreation at federal and most state lands, but it would have long-term impacts on recreational opportunities at some state recreation areas, sites, and parks in the vicinity of the pipeline. Existing access to public lands would remain, but access to, and recreational use of, the TAPS ROW corridor likely would be restricted during termination activities. Current recreational opportunities in the vicinity of the pipeline would continue on federal lands and most state lands. However, recreational opportunities at state recreation areas, sites, and parks would diminish as a result of a decrease in funding due to lost oil revenues. Consequently, the trend of increased recreational use on federal lands along the length of the pipeline would likely continue under the no-action alternative, but the use of some state recreation areas, sites, and parks likely would decrease because of reduced state funding, which would force closure of some areas, sites, and parks (Panarese 2002).

Most pipeline viewing opportunities would be lost after completion of termination activities. However, one or more segments of the pipeline could be retained for historical preservation.

The construction of the Dalton Highway, which was an indirect effect of the construction of the TAPS, has increased access to public lands north of the Yukon River, increased recreational opportunities, and caused a minor increase in recreational use in some areas (BLM 2001b). Whether or not renewal of the

Impacts of No-Action Alternative on Recreation, Wilderness, and Aesthetics

Recreation: Implementation of the no-action alternative would have mostly local and temporary impacts on recreation at federal and most state lands. It would have long-term impacts on recreational opportunities at some state recreation areas, sites, and parks near the TAPS because of reduced state funding (resulting from the loss of oil-related revenue) that would force the closure of some state recreation areas, sites, and parks. Existing access to public lands would remain, but access to, and recreational use of, the TAPS ROW corridor likely would be restricted during termination activities. The trend of increased recreational use on federal lands along the length of the pipeline likely would continue under the no-action alternative. Pipeline viewing opportunities would be lost after completion of termination activities unless one or more segments of the pipeline were preserved for historical purposes. Currently existing visual and noise impacts experienced by recreationists would be eliminated upon completion of termination activities.

Wilderness: Implementation of the no-action alternative would have no direct impacts and mostly temporary indirect impacts on the wilderness area within Gates of the Arctic NPP. During termination activities, machinery and personnel would be within sight and sound of the ridgelines at some points along the eastern wilderness boundary. Noise from vehicle traffic on the Dalton Highway and aircraft and helicopter traffic would increase and probably add to the noise currently audible in the wilderness area. However, these effects would be localized and temporary, and they would end upon completion of termination activities, as would the currently existing visual and noise impacts from the TAPS.

Aesthetics: Aesthetic impacts along the entire 800-mi length of the pipeline would temporarily increase during termination activities because of the presence of machinery and personnel and the disturbance of the soil surface during dismantlement and removal operations. However, upon completion of termination activities and as vegetation becomes reestablished on disturbed ground, these impacts would cease. In addition, for individuals who consider the presence of the pipeline to be a visual intrusion, that impact would be eliminated with removal of aboveground portions of the TAPS.

Federal Grant occurs, the Dalton Highway would remain open to the public, as would the BLM-maintained recreational facilities along the highway. The airports near the TAPS ROW corridor would also likely remain and could possibly continue to provide air access to remote recreational areas (TAPS Owners 2001a). Consequently, since current air access and road and BLM site maintenance could continue regardless of whether renewal occurred, the historical trend of increased recreational opportunities and use in some areas would also be expected to continue.

On BLM lands along the Dalton Highway and the TAPS ROW corridor, the current recreational opportunity spectrum classes of “roaded natural,” “roaded modified,” and “rural” would remain under the no-action alternative, along with their associated management objectives. The past trend of an increasing number of visitors at Coldfoot Visitor Center, Marion Creek Campground, and the Yukon Crossing Contact Station would likely continue (BLM 1989, 1991). Gates of the Arctic NPP, including the Wilderness Area within it, and the Arctic, Yukon Flats, and Kanuti NWRs have all experienced a small increase in recreational use in the last 25 years, which would also be expected to continue. Recreational use of White Mountain NRA, which has increased steadily over the past 15 years, would also likely continue.

Recreationists at some of the afore-mentioned areas would likely experience increased noise from machinery and personnel during termination activities. Coldfoot Visitor Center, Marion Creek Campground, and the Yukon Crossing Contact Station are within sight and sound of the pipeline, as are some ridgelines along the eastern boundary of the wilderness area within Gates of the Arctic NPP. Increased noise might also be heard on some state lands near the TAPS. However, noise from termination activities would likely not be heard within the Arctic, Yukon Flats, and Kanuti NWRs or the White Mountains NRA because of their distance from the pipeline. Aesthetic and noise impacts would be local and temporary and would end upon completion of termination activities. In addition, any existing noise and aesthetic impacts currently experienced by recreationists from normal operations and maintenance of the TAPS and related facilities would no longer exist if the TAPS ROW was not renewed.

The Richardson Highway, which existed as a paved highway decades before construction of the TAPS, would continue to provide access to public lands in the vicinity of the southern half of the TAPS. Under the no-action alternative, the BLM likely would continue to manage for the “roaded natural,” “semiprimitive motorized,” and “semiprimitive nonmotorized” recreational opportunity spectrum classes currently available on BLM lands along the southern half of the pipeline.

Currently existing recreational opportunities on the Delta and Gulkana National Wild and Scenic Rivers (WSRs) would not be affected by not renewing the TAPS ROW. However, because some portions of the pipeline come within one-half mile of both rivers and because the TAPS crosses the Gulkana River at one point, recreationists would likely experience increased noise from machinery and personnel during termination activities. This minor effect would be local and temporary, and it would end upon completion of termination activities.

The no-action alternative, including termination activities, would not interfere with the objectives of the BLM’s river management plans (BLM 1983a,b) and would not entail construction of any impoundments, structure, or diversions on either river (TAPS Owners 2001a). However, once the TAPS was removed and the corridor was restored, recreationists would no longer experience the current visual or noise impacts from the TAPS. Increased recreational use of both the Delta and Gulkana WSRs would be expected to continue, as indicated by past trends.

Current recreational opportunities would continue at Wrangell-St. Elias NPP and Chugach NF and most state lands, but they would decline at state recreation areas, sites, and parks as a result of reduced funding for operations and maintenance. Since Wrangell-St. Elias NPP has not documented an increase in recreational use since its creation after construction of the TAPS, implementation of the no-action alternative would not be expected to affect future use. Past trends indicate that the amount of recreational use at Chugach NF (near the Valdez Marine Terminal) would also be unaffected by a decision to not renew the TAPS ROW (Behrends 2002). Use levels at state recreation areas, sites, and parks along the southern half of the pipeline likely would decline, and some state facilities would probably close as a result of decreased revenue (Panarese 2002). Recreationists at Wrangell-St. Elias NPP and Chugach NF would be unlikely to experience increased noise from machinery and personnel during termination activities because of their distance from the pipeline; however, recreationists on some state lands could be affected. Any currently existing noise or visual impacts experienced by recreationists would be eliminated under the no-action alternative.

APSC visitor sites and viewing stations along the length of the TAPS would likely be removed along with the pipeline under the no-action alternative, resulting in a loss of this type of recreational experience. However, if segments of the pipeline were retained for historical purposes, some APSC visitor sites and/or viewing stations would also probably be retained. APSC would likely restrict recreational use within the TAPS corridor during termination activities. After removal and restoration activities were completed, recreation within the former TAPS ROW corridor would be subject to BLM and ADNR policies and management.

Termination activities would entail the possibility of a spill of crude oil or some other petroleum product that could affect recreation resources. Twelve potential spill scenarios have been developed for the no-action alternative and are presented in Table 4.6-2.

The spill scenario with the greatest potential release is the rollover of a tanker truck carrying kerosene from the Williams North Pole Refinery to Prudhoe Bay. In this scenario, 8,000 gal (about 190 bbl) of kerosene would be released instantaneously. This type of spill has the potential to occur one or more times every 2 years at some point along the pipeline. If the release occurred on land, kerosene would cover about 12 acres at a depth of 1 in. A spill into a water body would result in contamination problems downstream, with the extent largely determined by response efforts.

In both cases, minimal effects on recreation resources would be expected. Because kerosene volatilizes more quickly than most components of crude oil and is less persistent in the environment, the effects on recreation would be similar to, but less severe than, those described in Section 4.4.4.18.1 for an anticipated spill of crude oil. The potential for future impacts on recreation from a TAPS-related spill would no longer exist after the completion of termination activities.

4.6.2.24.2 Wilderness. No federal or state designated or proposed Wilderness Areas exist within or adjacent to the TAPS ROW corridor (ADNR 2001; APSC 1993; Delaney 2001). However, the eastern boundary of the federally designated Wilderness Area within Gates of the Arctic NPP is within 2 to 3 mi of the TAPS at its closest point (Ulvi 2001).

Implementation of the no-action alternative would have no direct impacts and only temporary indirect impacts on the wilderness area within Gates of the Arctic NPP and on the values that qualify it for wilderness designation. Currently, the pipeline is visible from some points along the easternmost ridgelines of the Wilderness Area, and some noise from Dalton Highway vehicle traffic and from aircraft flying over the TAPS corridor can be heard. During termination activities, machinery and personnel would be within sight and sound of the ridges at some points along the eastern wilderness boundary. Vehicle traffic on the Dalton Highway and aircraft and helicopter traffic would likely increase to support termination activities. Consequently, some increase in noise and visual impact would occur along the eastern boundary of the Wilderness Area in Gates of the Arctic NPP. However, these effects would be localized and temporary, and they would end upon completion of termination activities.

The currently existing minor visual impacts on the Wilderness Area would be reduced after dismantling and removal of the pipeline, since the pipeline would no longer be visible. The visual effects from the previous ROW would continue to lessen over time as revegetation occurred.

Current noise impacts on the wilderness area from vehicles on Dalton Highway and aircraft flying over the TAPS corridor would also decrease after completion of termination activities. However, some noise would continue to be heard along the eastern boundary of the Wilderness Area because Dalton Highway would remain open to the public. In addition, noise from the snowmachines, motorboats, and airplanes currently and historically used within the Wilderness Area would continue. Such usage is allowed in Alaskan wilderness areas pursuant to the Alaska National Interest Lands Conservation Act (ANILCA) of 1980.

The increased access to the wilderness area that has resulted from construction of the Dalton Highway and airports within the TAPS corridor would continue under the no-action alternative, since the Dalton Highway would remain open and airports within the TAPS corridor would also likely remain in place. Therefore, the minor increase in recreational use that has occurred since construction of the Dalton Highway in the eastern portion of the Wilderness Area within Gates of the Arctic NPP and has been noted by the National Park Service, likely would continue under the no-action alternative (Ulvi 2001).

In 1980, neither the visibility of the pipeline from the easternmost ridges of the wilderness area nor the minor traffic or aircraft noise audible there precluded the designation of the area as a wilderness area. The minor and temporary increased visual and noise impacts from termination activities would not affect the area's qualification as wilderness.

Even with implementation of the no-action alternative, including removal of the pipeline and subsequent revegetation of the corridor, the TAPS ROW corridor would not meet the criteria for federal wilderness designation as defined by the Wilderness Act of 1964. Both the TAPS corridor and adjacent areas would still have been altered by man and would not offer outstanding opportunities for solitude and primitive recreation because of their proximity to the highway(s). Since the areas would not meet these essential criteria, federal wilderness designation would not be possible (Overbaugh 2001). Consequently, implementation of the no-action alternative would not affect the suitability of the TAPS corridor for wilderness designation.

Implementation of the no-action alternative would also not affect state wilderness designation near the pipeline. The existence of the TAPS has not precluded state designations of wilderness in Alaska in the vicinity of the pipeline, and termination activities would not affect the potential for future designations (Mylius 2002).

Termination activities would entail the possibility of a spill of crude oil or some other petroleum product that could affect the wilderness area within Gates of the Arctic NPP. As discussed for recreation above (Section 4.6.2.24.1), the spill scenario with the greatest potential release is the rollover of a tanker truck carrying kerosene from the Williams North Pole Refinery to Prudhoe Bay.

The potential for impacts to the Wilderness Area is minimal because it is 2 to 3 mi west of the pipeline at its closest point, and a spill would have to occur between MP 139 and 266 to affect the area. The distance precludes the possibility of direct effects from a land-based spill, although easternmost ridgelines could be indirectly affected by the noise from cleanup activities. A spill directly into the Koyukuk River (between MP 139 and 266) could potentially reach the wilderness area where the Koyukuk River flows west along the southeastern boundary of the wilderness. Effects would be similar to, but less severe than, a similar volume spill of crude oil because kerosene volatilizes more quickly than most crude oil components and is less persistent in the environment. The potential temporary effects include damage to reparian vegetation along the Koyukuk River and loss of solitude near the affected area because of noise and personnel from cleanup activities. No potential for future impacts on Gates of the Arctic Wilderness Area from a TAPS-related spill would exist after completion of termination activities.

4.6.2.24.3 Aesthetics. The TAPS ROW passes through areas that contain outstanding visual resources. About half of the 800-mi length of the TAPS is above ground and clearly visible from the air, and most of the aboveground segments, including pump stations and related structures, are visible from adjacent public roads. The pipeline is within sight of some BLM sites and state recreation areas, sites, and parks, and it is visible from ridgelines along the eastern boundary of the Wilderness Area within Gates of the Arctic NPP. The TAPS is also visible from some BLM-managed ACECs and at a few points within the Delta and Gulkana WSR corridors, including locations where it is suspended above the Gulkana River. The pipeline is also suspended above the Tanana River within sight of Richardson Highway, and it is above the Yukon River on the same bridge that carries the Dalton Highway. In addition, the Valdez Marine Terminal is clearly visible from the City of Valdez (TAPS Owners 2001a; APSC 1993). These localized existing aesthetic impacts would be largely eliminated upon completion of dismantlement and removal of the aboveground components of the TAPS under the no-action alternative, and the impacts would be completely eliminated after revegetation of disturbed areas (see below). However, because aesthetics involve a value judgment, some visitors could perceive the removal of the TAPS and its related facilities to be an improvement to the visual landscape, while others could perceive it as detrimental.

During termination activities, aesthetic impacts along the entire 800-mi length of the pipeline would temporarily increase as a result of the presence of machinery and personnel and disturbance of the soil surface. In particular, the digging associated with cleaning and capping the belowground segments of the pipeline would result in temporary mounds of soil, and disturbed areas would remain as bare ground until vegetation became reestablished. Compliance with existing stipulations in the Federal Grant would minimize visual impacts.

The occasional, minor, and temporary visual air impacts that occurred in the past during tank-vent flaring at PS 1 would be eliminated under the no-action alternative. Mitigation measures for dust control would be used during termination activities to control any construction-related local and temporary air impacts that might occur.

Under the no-action alternative, portions of the former TAPS corridor would still lie within a BLM-designated utility corridor. Class IV VRM objectives, which allow major modifications to the existing landscape, would still apply.

A spill of crude oil or some other petroleum product during termination activities could potentially affect visual resources in the vicinity of the pipeline. The severity of the impact would be largely determined by the location of the spill. A spill visible from a public road, recreation site, or river would have a greater impact on aesthetics than one that is not as visible. Historically, most spills have been relatively small and have resulted in localized and temporary effects generally not visible to visitors except by air (TAPS Owners 2001a).

As discussed for recreation above (Section 4.6.2.24.1), the spill scenario with the greatest potential release during termination activities is the rollover of a tanker truck carrying kerosene from the Williams North Pole Refinery to Prudhoe Bay. Because kerosene volatilizes more quickly than most components of crude oil and is less persistent in the environment, the potential effects on aesthetics would be similar to, but less severe than, those described in Section 4.4.4.18.3 for an anticipated spill of crude oil. The potential for future impacts on visual resources from a TAPS-related spill would no longer exist after completion of termination activities.

4.6.2.25 Environmental Justice

This DEIS anticipates impacts under the no-action alternative that may be considered high and adverse, specifically those associated with economic effects at the state and local levels of discontinuing the TAPS (Table 4.6-24). As discussed in detail in Section 4.6.2.19, both because of Alaska’s heavy economic reliance on the oil industry and the central role that the TAPS plays in the Alaskan oil industry, the entire state would experience substantial economic impacts as a consequence of terminating the TAPS. In addition, short-term negative impacts to rural sociocultural systems may be high and adverse during termination activities, because of the influx of outside workers into communities near the TAPS. For purposes of understanding anticipated environmental justice impacts under the no-action alternative, the following discussion presents impacts at two levels of geographic focus: the entire state of Alaska and communities in the vicinity of the TAPS.

TABLE 4.6-24 Summary of Anticipated Impacts under the No-Action Alternative

Issue Area	EIS Section	Summary of Impacts[a]
Physiography and geology	4.6.2.1	Anticipated negative impacts would be localized and small.
Soils and permafrost	4.6.2.2	Anticipated negative impacts would be localized and small, confined largely to short-term silting and erosion and possible localized depressions from collapsed pipes.
Seismicity	4.6.2.3	No anticipated negative impacts.
Sand, gravel, and quarry resources	4.6.2.4	Anticipated negative impacts would be small and short term.
Paleontology	4.6.2.5	No anticipated negative impacts.
Surface water resources	4.6.2.6	Anticipated negative impacts would be localized, small, and temporary.
Groundwater resources	4.6.2.7	Anticipated direct negative impacts would be minor and localized; anticipated indirect negative impacts would be localized.
Physical marine environment	4.6.2.8	Anticipated negative impacts generally would be small and temporary.
Air quality	4.6.2.9	Anticipated negative impacts are expected to be small and decline considerably after Year 2 of termination activities.
Noise	4.6.2.10	Maximum anticipated negative impacts would likely occur during Year 3 of termination activities, at a level similar to those experienced in TAPS operations, declining thereafter and disappearing after Year 6.
Transportation	4.6.2.11	No anticipated negative impacts.
Hazardous materials and waste management	4.6.2.12	Anticipated negative impacts from the management of hazardous materials and waste would occur in accordance with existing permits, procedures, and regulations and would disappear after termination activities are completed.
Human health and safety	4.6.2.13	Anticipated negative impacts to workers, including fatalities and injuries, would be of a magnitude similar to rates observed by the National Safety Council in such activities; anticipated impacts to the public would be small.

TABLE 4.6-24 (Cont.)

Issue Area	EIS Section	Summary of Impacts[a]
Biological resources	4.6.2.14, 4.6.2.15, 4.6.2.16, 4.6.2.17, and 4.6.2.18	Anticipated negative impacts to vegetation are expected to be small and localized; anticipated negative impacts to fish are expected to be small and temporary, generally confined to termination activities; anticipated negative impacts to birds and terrestrial mammals are expected to be small and localized, primarily confined to termination activities, with no population-level impacts; anticipated negative impacts to threatened, endangered, and protected species are expected to be confined largely to termination activities and are not expected to exceed population-level impacts accompanying natural variation.
Economics	4.6.2.19	Anticipated negative impacts to the national economy include a shift in the balance of trade, loss of important federal tax revenues, and declining ship building; anticipated negative impacts to the state economy include initial declines in gross state product, population, employment, personal income, and tax revenues with the termination of TAPS activities, followed by slow growth through 2034.
Subsistence	4.6.2.20	Anticipated impacts would include both positive and negative effects; overall impacts likely would be positive but small.
Sociocultural systems	4.6.2.21	Anticipated impacts would include both positive and negative effects over the short and long term; overall impacts likely would be negative, due primarily to reduction in Alaska Native and rural non-Native opportunities for wage employment and reduced state-funded programs and public services, although both of these should recover over time with the slow economic growth projected; and due to the influx of outsiders into communities near the TAPS during termination activities, although these effects should be short-term and less pronounced than during pipeline construction.
Cultural resources	4.6.2.22	Any possible negative impacts, both to the TAPS itself (which is a unique and potentially significant cultural resource) and to other cultural resources, would be mitigated through procedures developed in consultation with the Alaska SHPO.
Land use and coastal zone management	4.6.2.23	No negative impacts on land use or land ownership are anticipated; anticipated negative impacts on coastal zone management are expected to remain in compliance with enforceable policies and applicable statewide standards.
Recreation, wilderness, and aesthetics	4.6.2.24	Anticipated negative impacts to recreation are expected to be largely short term (although some would be long term because of reduced state funding) and generally small; anticipated negative impacts to Wilderness Areas would be small and generally indirect; negative impacts to aesthetics are expected to be short term, confined mainly to termination activities.

[a] Impacts are summarized here for the convenience of the reader. Details of the impact evaluations could not be included because of space limitations; additional information may be found in the referenced EIS sections.

No-Action Alternative and Environmental Justice

Environmental justice impacts would be expected because of economic consequences and socioeconomic effects that can be judged as high and adverse:

- Large reduction of state revenues and hence reduced ability of the state to provide programs and public services relied upon by many minority or low-income populations in rural areas.
- Large, short-term influxes of nonlocals into rural communities close to the TAPS during termination activities.

Possible positive consequences include short-term access to cash employment in areas close to the TAPS during termination activities.

For the state, environmental justice impacts under the no-action alternative are anticipated for both minority and low-income populations. As noted in Section 3.29, both populations occur in disproportionately high percentages in census block groups covering much of the geographic extent of Alaska. As a result of the combined presence of high and adverse impacts and disproportionately high representation of minority and low-income populations, noteworthy environmental justice impacts would accompany the no-action alternative. These impacts would occur precisely where the disproportionately high representations of the two environmental justice populations occur, thus giving the environmental justice impacts a geographic correlate for each population type.

In describing the affected environment, this DEIS interprets the term “disproportionality” in geographic terms; namely, as the percentage of a particular sector of the population in a specific geographic unit being higher than some reference figure (in this document, the percentage of that population in the state as a whole). However, the nature of anticipated economic impacts under the no-action alternative introduces another possible interpretation: adverse effects that are more serious for minority or low-income populations than for the remaining state residents, regardless of the geographic distribution of these populations. In the case of minority populations, the severe economic impacts anticipated likely would reduce or eliminate various state and local programs available to residents throughout the state through General Fund community support programs. Examples include the state revenue sharing program, the safe communities (municipal assistance) program, legislative grants, and capital project matching grants, which provide funds to eligible communities for a range of infrastructure development and maintenance activities and public services (ADCBD 2002a,b). Much of the assistance from these programs goes to rural locations to provide infrastructure and services that rural communities otherwise could not afford. As shown in Table 3.29-1, many of the rural communities examined in this document contain high percentages of minority populations, particularly Native peoples. Although state and local programs would suffer in general under the no-action alternative, by virtue of their heavy reliance on such programs, minority populations in rural communities would experience greater negative impacts than the state population as a whole.

For the low-income population, the consequences of economic impacts under the no-action alternative would be similar to those for Alaska’s minority population. Once again, one of the most serious impacts would be reduced access to state and local government programs — programs upon which low-income populations, because of their reduced financial means, rely more heavily than does the population as a whole.

Economic impacts with environmental justice implications under the no-action alternative in communities close to the TAPS would be similar to those discussed above for the state as a whole. However, they would be timed differently and follow a brief financial windfall. As discussed in Section 2.4 under the no-action alternative, the TAPS would be shut down and decontaminated, and aboveground sections of pipeline and supports would be removed. These termination activities would occur over 6 years and require as many as 5,219 (peak year) employees to work on various aspects of the termination process (TAPS Owners 2001a; see also Section 4.6.2.19.1). Many of these individuals likely would be hired from communities located close to the TAPS — providing direct income to individuals who likely would include minority and low-income persons because of their heavy representation in these communities. Local Alaska Natives in particular should experience a surge in employment, and thus income, because of the provision outlined in Section 29 of the Federal Grant that provides for Native Utilization Agreements to establish levels of Native hires, coupled with their proximity to the TAPS. Moreover, the additional wages earned near the TAPS during termination activities would provide indirect income to various sectors of the local economy (see Section 4.6.2.19). Once again, some of these indirect impacts likely would benefit the disproportionately large percentages of minority and low-income individuals in communities close to the TAPS.

The positive economic benefits of the no-action alternative to local communities would be temporary. Eventually, the short-term economic gains would disappear, and the minority and low-income populations close to the TAPS would experience the same types of adverse economic impacts projected for the remainder of the state.

The analysis of impacts to sociocultural systems under the no-action alternative concludes that high and adverse impacts of a type similar to those experienced during TAPS construction likely would accompany the anticipated influx of nonlocal workers. That stated, because isolation of rural areas in proximity to the TAPS is considerably less now than during construction, impacts to sociocultural systems should be less during termination activities than during construction. In addition to increased inconvenience — for example, increased traffic, competition for services, and strains on local businesses to meet the surge in demand, all of which change the character of a particular community — both rural and urban settings experienced increased crime, including increased substance abuse, when the TAPS was built (Dixon 1978; Reckord 1979). Such changes likely would affect low-income and minority populations differently, particularly Alaska Natives, than they would the population as a whole. In the case of impacts in urban settings, notably Fairbanks, as in the 1970s, Natives from the interior often use this city as a hub for transportation and social gatherings. Increasing difficulties in finding adequate services, such as lodging, and growth in crime, would affect these people in a negative manner — in many cases, greater than they would affect the remaining population because of the frequent financial constraints of Alaska Natives. Additional exposure to crime, particularly substance abuse, may add to such problems in a sector of society already disproportionately affected by it. Finally, the influx of nonlocal workers likely would interrupt the normal flow of sociocultural relationships within Alaska Native communities because of the addition of large numbers of outsiders, similar to what occurred in Copper Center during TAPS construction (Reckord 1979).

The surge of short-term migrants relocating to work on activities related to the no-action alternative likely would have disproportionately high and adverse impacts on low-income populations in the vicinity of the TAPS as well. As occurred during TAPS construction, supply and demand for housing and many goods and services drove prices up in the vicinity of the pipeline and related facilities (Dixon 1978). Such localized inflation would particularly affect the low-income population, those most unable to pay, although negative impacts may in part be countered by growing employment opportunities in the proximity of TAPS during termination activities. Localized inflation also would have a disproportionately high impact on minorities in local communities, since this population also tends to have lower income than the remainder of society and thus would be more sensitive to increased prices. In the case of Alaska Natives, hiring under Native Utilization Agreements considered via Section 29 may reduce the impacts of localized inflation more than for the low-income population as a whole, the latter lacking any such hiring provision.

As discussed in Section 4.6.2, all long-term impacts anticipated under the no-action alternative are not necessarily negative. For example, improvements in subsistence may occur through the out-migration of many individuals who compete with rural residents for subsistence resources, and the emergence of an economy that is not necessarily as conducive to sport hunting and fishing as the present economy. Similarly, the out-migration and economic conditions anticipated under no action may yield a situation that is less disruptive to Alaska Native and rural non-Native sociocultural systems than is currently the case, thereby producing a type of improvement in this impact area. However, the adverse impacts associated with removing the key component of the state economy likely would have short-term high and adverse impacts on environmental justice populations. Focusing attention on both economic and sociocultural impacts likely would help to reduce impacts. Prioritizing support for state-funded programs and services most important to minority and low-income Alaskans, for example, would help to continue those programs contributing the greatest good to environmental justice populations, until state revenues recover sufficiently to reinstate increased funding. Similarly, carefully planning for local sociocultural impacts during termination — through sensitizing incoming workers to such issues, providing adequate temporary housing to reduce housing impacts, and adding law enforcement personnel to areas experiencing particularly rapid influxes of nonlocals — would help to reduce negative effects in certain areas while the TAPS was being disassembled.